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Laser Inductive Reaction by O_2 Laser

43067600a Tokyo DAINANAKAI HIKARI GA KAKAWARU SHOKUBAI KAGAKU SHIMPOJIUMU in Japanese 30 May 88 pp 1-2

[Article by Maka Kawai, Yoshiko Tsuboi, and Kazunori Tanaka, Institute of Physical and Chemical Research: "Research on Laser Inductive Reaction on Oxide Surface (Mechanism of CO_2 Laser Inductive Reaction)"]

[Text] We tried to carry out a CO_2 laser inductive reaction test on the surface of a solid and studied its reaction mechanism by investigating the reaction behavior on the surface.

We have already clarified the reaction mechanism of an O_2 laser inductive reaction for CDF_3 on a SiO_2 surface. Two reactions occurred simultaneously in the course of the experiment. One is a photochemical reaction characterized by the generation of OD and CF species. This is caused by the excitement of CDF_3, which is physically adsorbed on the SiO_2 surface. The other is a thermal desorption reaction on the OH surface group produced by the excitement of the SiO_2.

In our research, we tried to produce a CO_2 laser reaction in a similar manner, using TiO_2 as its reaction substrate.

We prepared a test piece by coating a NaCl sheet (20 mm in diameter) with an ethanol suspension of TiO_2 (Aerosil P25 ca. 50 m^2/g) sprayed from an atomizer. The test piece was put into an infrared cell where it was heated for 4 hours at a temperature of 410°C, using about 30 Torr of oxygen. We then attempted to discharge the oxygen for about 1 hour in its heated state, then cooled it down to room temperature. A reaction gas (CDF_3, NH_3) was introduced into the test piece after the pretreatment and the test piece was irradiated with a TEA CO_2 laser (Lumonica 103-2). Next, we tried to observe the surface generation species using the infrared transmission method (NICOLET FT-IR 5DX) after the discharge of the air phase portions.

When we attempted to introduce CDF_3 (10 Torr) over the TiO_2 after the pretreatment and laser irradiation (971.93 cm^{-1}), a new absorption by the CDF_3 at 1209 cm^{-1} and 1110 cm^{-1}. Figure 1 shows this infrared absorption spectrum.

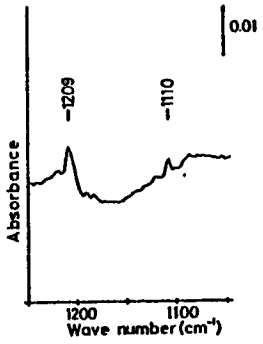


Figure 1. IR Spectrum After Laser Irradiation of the TiO_2 and CDF_3

The surface CF_2 species generation reaction is generated by the excitement of either the physically adsorbed CDF_3 or the air phase CDF_3.

Figure 2 shows the relationship between CDF_3 pressure and the generation of CF_2 (ad). Here (a) represents the case where a laser light irradiates the TiO_2 surface in parallel. More specifically, it represents the CDF_3 excitement reaction. Meanwhile, (b) represents the case where the excitement is produced by vertical irradiation. In other words, it represents the case where the physically absorbed CDF_3 contributes to a great extent. Figure 3 shows the effect of laser wave length on the generation of CDF_3 (ad) when an attempt is made to train the laser on the TiO_2 horizontally (a) and vertically. The figure shows that the excitement of the CDF_3 advances the reaction in the case of horizontal incidence (a) while the excitement of the physical absorbance of CDF_3 becomes dominant in the case of vertical incidence (b). At the same time, the reaction involving the excitement of physically adsorbed species shows its secondary dependence on the intensity of the laser.

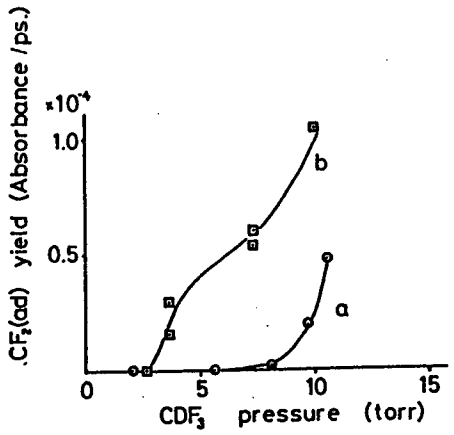


Figure 2. CDF_3 Pressure Dependency on the Generation of CF_2 (ad)
(a) Laser irradiation of the air phase only.
(b) Laser irradiation of the TiO_2.

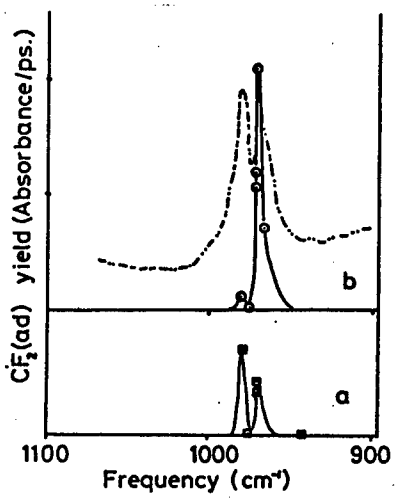


Figure 3. Dependency of Laser Wave Length on the Generation of CF_2 (ad)
(a) Laser irradiation of the air phase only.
(b) Laser irradiation of the TiO_2.

The CO_2 laser excitement reaction of the CDF_3 (ad) on the SiO_2 showed the third dependence--intensity of the laser--while the surface reaction product turned out to be CF (ad) and OD (ad).

20136/6091

Interaction of Water, Oxygen on Semiconductor Surface

43067600b Tokyo DAINANAKAI HIKARI GA KAKAWARU SHOKUBAI KAGAKU SHIMPOJIUMU in Japanese 30 May 88 pp 24-25

[Article by Shinri Sato, Catalysis Research Institute of Hokkaido University: "Interaction of Water and Oxygen on the Semiconductor Surface Subjected to Light Emission"]

[Text] Introduction

The water or oxygen adsorbed on a semiconductor reacts with the electrons or holes generated by the emission of light. It is thought that an OH radical or the like is produced in the case of water, while O is produced in the case of oxygen. Therefore, it is thought that some interaction (reaction) is present when water and oxygen coexist. The interaction between water and oxygen produced by increased light irradiation is associated with the generation of oxygen due to the photooxidation of water. This phenomenon is also interesting from the standpoint of studying the mechanism of the interaction. In this experiment, we tried to obtain information about the interaction mechanism between water and oxygen and the reaction mechanism for the generation of oxygen from water by investigating the oxygen optical isotope exchange reaction (OOIE) and the oxygen optical isotope improved equilibrium reaction (OIIE).

Experiment

Using TiO_2 (merck, anatase) as a semiconductor, we tried to carry out a reaction experiment within an enclosed circulation system. We spread 0.3 g of TiO_2 all over a reactor with a flat bottom and degased at a temperature of 200°C. We then tried to introduce a constant vapor pressure and $^{18}O_2$ (99 at.%) into the reactor and irradiated light from the upper part. We carried out the irradiation through a UV-D33S filter (240-400 nm), using a 500 W extra-pressure mercury lamp as a light source. We analyzed the isotope distribution of oxygen with a mass filter.

Result and Examination

When TiO_2 is used as a test piece, neither the OOIE nor the OIIE occurs, if the introduced vapor pressure is high. However, both the OOIE and OIIE can

be generated if an attempt is made to discharge the water during the air phase and to retain only the adsorped water. Figure 1 shows that the OOIE occurs at a temperature of about -26°C (1 Torr of vapor pressure and below) when a part of the reaction system is cooled down to trap the vapor. In this case, the OIIE can be produced as well, but its reaction speed is much faster than that of the OOIE. As indicated in Figure 2, the OOIE can occur even when the test piece is heated to temperatures just above 60°C. Increasing the temperature further accelerates the reaction speed. Interestingly, however, the air phase oxygen fails to become an isotope exchange equilibrium. In other words, the OIIE is very slow compared to the OOIE.

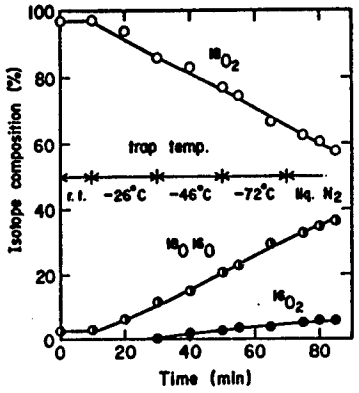


Figure 1. Oxygen Optical Isotope Exchange With $^{18}O_2$ and $H_2{}^{16}O$ on TiO_2 and the Influence of Vapor Pressure

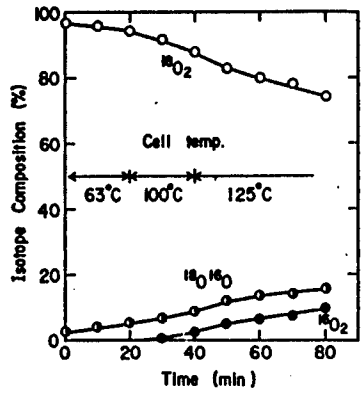


Figure 2. Oxygen Optical Isotope Exchange With $^{18}O_2$ and $H_2{}^{16}O$ on TiO_2 and the Influence of Reaction Temperature

The oxygen optical isotope exchange will not occur when the vapor pressure is higher. The reason may be attributed to the following factors:

1. Since water is strongly adsorbed to the TiO_2 surface, the oxygen cannot be adsorbed.

2. The light generation electrons and holes react with the water selectively and the reaction products fail to carry out the oxygen isotope exchange.

We tried to investigate the question of whether or not the optical luminescence of the TiO_2, to which water is adsorbed, will become extinct (about 2 Torr) in order to see if the oxygen fails to absorb when the water is adsorbed to the TiO_2. It was determined that the extinction of light by oxygen is about 20 percent when the water is adsorbed, thus preventing the adsorbance of the oxygen. Therefore, the adsorbance of the oxygen on the TiO_2 is thought to be attributable to the failure of the optical isotope exchange. Most interestingly, moreover, the optical isotope exchange will not occur, although the oxygen is physically adsorbed on the adsorption water and the adsorption water is considered to be optically excited.

The reduction in the adsorption of water allows the oxygen to be adsorbed, which can produce the optical isotope exchange. In this case, the oxygen is optically dissociated in atomic shape and reacts with the water, thus generating hydrogen peroxide, which is thought to play the part of intermediary for the exchange reaction. More specifically, the reaction process can be expressed by the following formulas:

$$^{16}O_2 + h^{\cdot} + e^{-} \rightarrow 2\,^{16}O\,(a) \qquad (1)$$

$$^{16}O\,(a) + H_2{}^{16}O \rightarrow H_2{}^{16}O\,{}^{16}O \qquad (2)$$

$$H_2{}^{16}O\,{}^{16}O \rightarrow {}^{16}O\,(a) + H_2{}^{18}O \qquad (3)$$

$$2\,^{16}O\,(a) \rightarrow {}^{16}O_2 \qquad (4)$$

However, we have failed to obtain a concrete confirmation of the optical generation of hydrogen peroxide on the surface of the TiO_2, as far as our research is concerned.

When a metal is loaded to the TiO_2, the experiment will produce quite a different result. More specifically, the OOIE can occur even if the vapor pressure is high. Furthermore, $^{16}O_2$ can be generated at a speed equivalent to or faster than $^{16}O\ ^{18}O$ as illustrated in Figure 3. This result indicates that the OIIE can occur later than the OOIE. However, the OOIE can occur faster than the OIIE, if the vapor pressure is reduced. Figure 3 shows the results obtained when Pt is loaded to TiO_2, but the same result can be obtained even if Au is loaded. Most important in this case is that the OOIE can be generated while the OIIE cannot. This suggests that the generation of the OOIE is not attributable to the optical activation of oxygen.

When a metal such as Pt is loaded to the TiO_2, the photodissociation of water will occur, which is a well known fact. In other words, hydrogen is generated by the reduction of water on a metal. But at the same time oxygen is generated by the oxidation of water on the TiO_2. The $^{18}O_2$ in the air phase fails in the adsorbance since water is powerfully adsorbed on the TiO_2. However, it is thought that the $^{18}O_2$ can be adsorbed on metals. Since adsorption hydrogen atoms are present on metals, these atoms are oxidized by

the presence of oxygen and are turned into water. On the other hand, the water is oxidized on the TiO_2, thereby producing oxygen. This is the reason why the $^{16}O_2$ is mostly generated. The chemical process can be expressed by the following formulas:

$$H^+ + e^- \rightarrow H(a) \quad (5)$$

$$2H(a) + {}^{18}O_2(a) \rightarrow H_2{}^{18}O_2(a) \quad (6)$$

$$H_2{}^{18}O_2(a) \rightarrow H_2{}^{18}O + {}^{18}O(a) \quad (7)$$

$$2H(a) + {}^{18}O(a) \rightarrow H_2{}^{18}O \quad (8)$$

$$2H_2{}^{18}O + 4h^+ \rightarrow {}^{18}O_2 + 4h^+ \quad (9)$$

Even when a metal is not loaded, the generation of $^{16}O_2$ will be increased if an attempt is made to raise the reaction temperature. The reason for this may be explained by the fact that an especially powerfully activated site on the TiO_2 plays a similar role to metals.

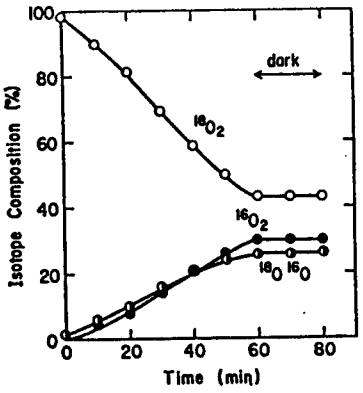


Figure 3. Oxygen Optical Isotope Exchange With $^{18}O_2$ and $H_2{}^{16}O$ on Pt/TiO_2

As discussed above, we have acquired some new information by investigating the optical isotope exchange of water and oxygen. However, we have yet to accomplish the purpose of our investigation into the oxygen generation mechanism in terms of the photodissociation of water on the TiO_2. This is because the oxygen isotope exchange occurs in routes other than the oxidation of water.

20136/6091

Optical Activation of Complex Catalyst

43067600c Tokyo DAINANAKAI HIKARI GA KAKAWARU SHOKUBAI KAGAKU SHIMPOJIUMU in Japanese 30 May 88 pp 38-41

[Article by Hiroshi Moriyama and Akira Yabe of the Chemical Engineering Research Institute: "Optical Activation of Complex Catalyst Due to Optical Excitement by Excimer Laser"]

[Text] 1. Introduction

The excimer laser has demonstrated that it is possible to obtain a strong monochromatic pulse light in the ultraviolet region. We have already reported our attempt to effectively use this feature, which is based on organic and synthetic chemistry, so that benz (cd) indazole[1] and [polychis] azobenzen[2] may be generated efficiently with polymetric reaction produced by the coupling between the molecules. In addition, we discovered that irradiation by an excimer laser causes the chain reaction, even in conditions where dehydrochlorination is generated by acrylicchloride from 1.2 dichloropropane.[1] We have also reported the example of hydrogenation,[4] in which the light excitement from an excimer laser dramatically activates the homogenous complex reaction and enhances the carbonyl produced by way of the C-H coupling activation of the hydrocarbon.[5] In this article, we have also summarized the reaction of the homogeneous class-hydrogenation produced by the light irradiation of an excimer laser. We would like to defer discussion of the reaction associated with the C-H coupling activation to another occasion.

In the field of complex catalysts, many attempts have been made to explore the highly efficient catalytic reaction produced by laser excitement.[6] To date, only a few examples of the reaction have been reported. Furthermore, its catalyst is limited only to the case of the metal carbonyl $(CO)_n$, which has a high optical reactivity. Accordingly, we tried to make a comparative study of the catalyst activation by thermal reaction and by light irradiation from a stationary light and by an excimer laser in terms of the olefin class-hydrogenation reaction produced by the complex catalyst, including the third grade phosphine or the like. As a result, we found out that $[RhH(CO)(PPh_3)_3]$ has a high optical catalytic activation. Once an activation species is generated by the excitement of an excimer laser, the residual effect of light irradiation can be observed without allowing the

laser irradiation to be lowered to the thermal reaction activation even if an attempt is made to stop the laser irradiation. Furthermore, we would like to report our discovery that the optical catalytic reaction can be produced by laser excitement where the quantum yield exceeds 1.

2. Experiment

To carry out our experiment, we used an EMG 103 excimer laser (XeCl: 308 nm) manufactured by Lamba Physiks Corporation. Its design is based on a pulse repetition ranging from 1 to 100 Hz and an optical intensity of ca. 70 mj/pulse. We used a 4 x 1 x 1 horizontal quartz cell for the reactor. We attempted to irradiate the light flux (ca. 0.8 x 2.5 cm) directly from the laser. As for irradiation by stationary light, we used an outside irradiation-type high-voltage mercury lamp (USHIO USH-500D). We tried to cut the thermal region through the application of a water filter and a RA-25S filter. We used a UV-25 filter in order to cut the light flux in the ultraviolet region. Further, we attempted to reduce the light flux to about 1 cm in diameter, using a conex lens, and then irradiated the light flux. We used an optical energy meter (Genter ED-500) to measure the quantity of light thus irradiated. We arranged for hydrogen gas to be supplied from a rubber gas sphere into the reaction system, which was designed to meet the deaeration requirements before being filled with gas. We attempted to carry out the hydrogenation reaction at an ambient temperature and atmospheric pressure. We attempted to analyze the products with GC (Shimazu GC-4C; Thermon 1000) and to measure the conversion rate using an analytical curve. A sample reaction: The RhH (CO)(PPh), which is dissolved in toluene, is added to the toluene solution of ethylacrylate, which is its substrate, using a syringe. The reaction starts while the solution is being vigorously mixed. The catalytic density is 2.0×10^{-3} while the substrate density is 0.8 M.

3. Result and Examination

Figure 1 shows examples of the hydrogenation reaction of ethylacrylate, which uses [RhH (CO) $(PPh_3)_3$] as its catalyst. The [RhH (CO) $(PPh_3)_3$] indicates a high activation in the hydrogenation of a homogeneous system[7] or in the hydroformyl, which was already discovered by Wilkinson. In addition, Strohmeier reported that the ultraviolet irradiation improved its activation.[9] As clearly indicated in Figure 1, activation of the hydrogenation reaction can be enhanced by irradiation from a high-voltage mercury lamp. The activation can be further improved by irradiation from an XeCl laser (308 nm) so that the conversion rate to ethyl propionate reaches 100 percent within 2 hours at frequencies of 1 Hz and 10 Hz. Irradiation at 100 Hz lowered the reaction speed to the level of the reaction activation under irradiation from a high-voltage mercury lamp; it generated the deposit of metal rhodium at the same time. If an attempt is made to irradiate the laser light intermittently, it is now clear that the reaction activation does not drop to the level of the thermal reaction activation, even when the light is cut. This suggests that the high density catalytic activation species generated by laser irradiation has a relatively longer life in the system.

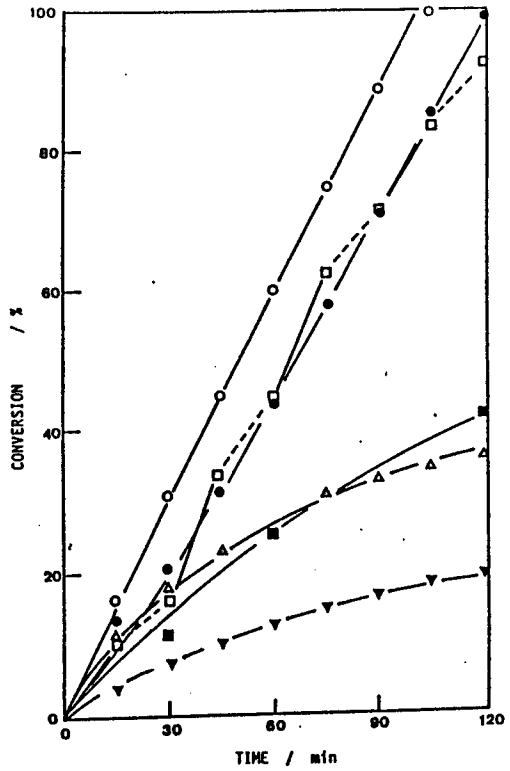


Figure 1. Time course of hydrogenation of ethylacrylate with RhH (CO) $(PPh_3)_3$ under thermal, high-pressure Hg lamp irradiation, and XeCl laser irradiation (308 nm, 1 Hz); RhH (CO) $(PPh_3)_3$ (2.0×10^{-3} M) and ethylacrylate (0.8 M) in toluene (3.2 mL). Note the enhanced dark reaction observed during the interval photolysis. (V) unirradiated reaction at room temperature; (■) under high-pressure Hg lamp irradiation; (●) under XeCl laser irradiation (1 Hz); (o) under XeCl laser irradiation (10 Hz); (Δ) under XeCl laser irradiation (100 Hz); (□) under interval XeCl laser irradiation (1 Hz). (——) irradiated period, (---) unirradiated period.

Figure 2 shows the density dependence of the catalyst [RhH (CO) $(PPh_3)_3$ on the hydrogenation of ethylacrylate. The reaction speed increases linearly until the catalyst density reaches about 1×10^{-10}. However, when the catalyst density exceeds that value, activation under the laser irradiation can be fixed, if the contribution of the thermal reaction activation is deducted. In other words, this signifies that the catalyst can absorb 100 percent of the laser irradiation light.

It is often said that the generation of nonsaturation ligand activation species by optical desorption constitutes a key step in the catalyst cycle under the optical catalytic action of the complex.[9] It has also been clarified that the high density nonsaturation ligand activation species is generated by the irradiation of an excimer laser under the optical catalytic action of a metal carbonyl complex catalyst. In fact, an extremely high turnover speed or quantum yield is reported under the isomerization reaction

of orefin[12] where $Fe(CO)_5$ or $Cr(CO)_6$ is used as a catalyst under the irradiation of an excimer laser. It was also learned that excitement by an excimer laser is quite effective even under the water gas shift reaction.[13]

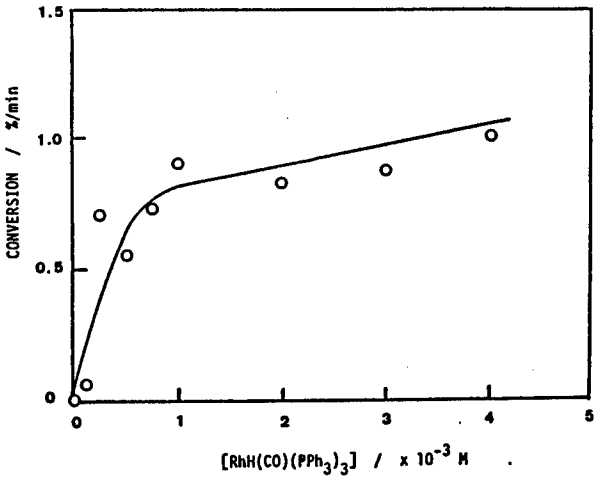
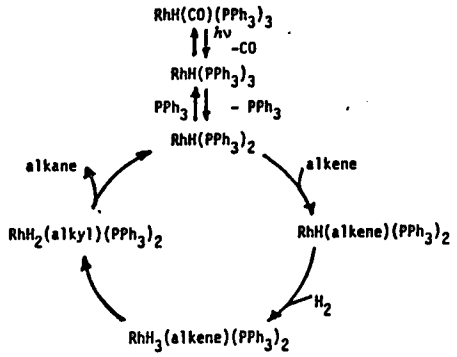


Figure 2. Dependence of the hydrogenation rate on catalyst solution concentration under XeCl laser irradiation (1 Hz); ethylacrylate 0.8 M in 3.2 mL toluene solution.

Even with the hydrogenation of ethylacrylate the quantum yield is 2.4, thus exceeding 1 under the optimum condition in which the pulse repetition is 1 while the catalyst concentration is 1×10^{-3} M. Figure 1 clearly shows the residual effect of the activation caused by the excimer laser. From this residual effect, we assumed that the reaction cycle may follow the pattern depicted in Scheme 1. Ford demonstrated that the CO ligand is subjected to optical adsorption by the irradiation of light, thereby generating the ligand nonsaturation species in terms of the complex, including carbonyl ligands, according to the flashing photodissociation method that relates to the Vaska-type complex.[14] By irradiating the light of the Vaska-type complex isolated from the Ar matrix, the CO ligand dissociation can be confirmed.[15] Therefore, even in this system, it is thought that irradiation from an excimer laser may dissociate the CO ligands as well. Furthermore, since the phosphine ligands are generally subject to dissociation and equilibrium in the catalyst dissolution, "$RhH(PPh_3)_2$" is assumed to be an activation species. If an attempt is actually made to let the phosphine--whose volume is 10 times greater--coexist in the reaction system, the reaction speed dropped to about one-half.

$$RhH(CO)(PPh_3)_3 \xrightarrow{h\nu} RhH(PPh_3)_3 + CO \qquad (1)$$

$$RhH(PPh_3)_3 \rightleftharpoons RhH(PPh_3)_2 + PPh_3 \qquad (2)$$



Scheme 1. Proposed Scheme of Catalytic Cycle for Hydrogenation With $RhH(CO)(PPh_3)_3$ Under Photoirradiated Conditions

Table 1 shows several hydrogenation reactions. The luminous energy irradiated by a high-voltage mercury lamp is 170 mj/sec, which is an actually measured value. Compared with 70 mj, which is the luminous energy when the excimer laser is irradiated at 1 Hz, the number of irradiated light quantums is greater, but the reaction efficiency is more favorable in the latter case. As a catalyst, $[RhH(CO)(PPh_3)_3]$ indicates a greater activation of hydrogenation reaction under the excimer laser excitement compared with the Vaska complex $[IrCi(CO)-(PPh_3)_2]$ or the Wilkinson complex $[RhCi(PPh_3)_3]$.

Table 1. Excimer Laser Induced Photocatalytic Hydrogenation

catalyst precursor (concn. M)	irradn. conditions λ/nm (energy, mJ)	irrad. frequency (Hz)	substrate (concn, M)	solvent (mL)	product conv. (%/h)
$[RhH(CO)(PPh_3)_3]$ (2×10^{-3})	L	1	ethylacrylate (0.8)	toluene (3.2)	43.5 ethylpropionate
	L	10			62.2
	L	100			26.7
	H	–			26.2
	D	–			19.3
$[RhH(CO)(PPh_3)_3]$ (2.5×10^{-4})	L	1			37.5
$[RhCl(PPh_3)_3]$ (2×10^{-4})	L	1			18.3
$[IrCl(CO)(PPh_3)_2]$ (5×10^{-4})	L	1			11.9
$[RhH(CO)(PPh_3)_3]$ (2×10^{-3})	L	1	1-hexene (0.8)	toluene (3.2)	47.7 n-hexane
	D	–			17.9
	L	1	2-propene-1-ol (0.8)	benzene (3.2)	15.1 n-propanol
	D	–			4.0

L, XeCl laser (308 nm) at 70 mJ per pulse; H, filtered high pressure mercury lamp at 170 mJ per second, see text; D, dark (thermal) reaction at room temperature.

Polybenzoxazole is stable against heat of 400 to 500°C and has excellent resistance to chemicals. The application of the film is under consideration as an insulating film for a compound semiconductor such as gallium-arsenic, and for a non-linear optical material which decreases the wavelength of incidental light to one-half or one-third.

13382/9604

Biotech Expert System Standardization

43066085 Tokyo SEMINAR ON STANDARDIZATION OF BIOTECHNOLOGY EXPERT SYSTEM in Japanese Apr 88 pp 1-24 (Part I), pp 1-12 (Part II)--FOR OFFICIAL USE ONLY

[Two-day seminar with three papers each day on "Trends and Prospects of Standardization of Biotechnology Expert System," held on 5-6 April 1988 under aegis of Kagaku Kogyo Nipposha]

[Excerpts] **Part I (5 April 1988)--Future Policies on Biotechnology Standardization, by Yasunari Wada, Industrial Standards Investigator, Standards Department, Agency of Industrial Science and Technology, MITI**

1. **Basic Policies for Biotechnology Standardization**

Because of remarkable technological progress in biotechnology, we are witnessing nonuniformities in qualities of, lack of unity in indications of, and differences in testing and evaluation methods for apparatus, equipment, and reagents used in biotechnological fields. Apparatus, equipment, and reagents are commonly basic to all the biotechnological fields. Therefore, the sine quo non for full-scale commercialization of biotechnology is to clarify concepts and assure easy comparative investigations, as well as to establish "agreements," which are the bases for standardization, by unifying terminologies, methods of indication, and methods of testing and evaluation.

However, standardization and establishing specifications must not be so unreasonable as to impede the technological progress of biotechnological fields. On the other hand, specifications themselves must not be such that they cannot catch up with the technological progress or soon become outdated, or have values set at too low a level (the so-called convoy method).

In other words, it is necessary to timely execute the standardization of biotechnological fields while closely examining the needs of standardization, so that the standardization will function as a part of the key organization of biotechnology industries and as a support base for research and technical development. In the execution, it is important to remember that basic parts should be standardized as soon as possible to encourage free competition in that framework.

2. Establishment of JIS Specifications Based on Long-Range Plan

The Standards Department of the Agency of Industrial Science and Technology received a proposal from the Japan Industrial Standards Committee (JISC) and in August 1986 drafted, by category, a long-range plan in which the schedule for the establishment plans through FY89 were summarized.

3. Systematic Survey for Specification Establishment

It is necessary to standardize systematically the above-listed items for JIS specification by connecting them in an organic fashion, instead of doing each item individually. In certain cases, such as the activity measurement methods for enzymes and the capability evaluation methods for apparatus and equipment, experiment is needed to establish JIS specifications. Based on these viewpoints, in FY87 we began the survey extending over several years on the following two topics to gather basic information for establishing JIS specifications.

3.1 Survey Concerning Standardization of Bioprocesses

This survey seeks to gather basic information for JIS establishment, particularly for the below-listed items, focusing our attention on bioprocesses from the stage of microbial culture and fermentation through the stage of product isolation and purification. The information is expected to become an important pillar for the future biotechnology standardization (see diagram).

A. Instruments and equipment for bioprocess control
B. Fixing materials for biological catalysts and fixed biological catalysts
C. Rapid automatic physical property measurements
D. Method of determining isolation and purification capabilities
E. Degree of air-tightness and method of measurement
F. Bioprocess reagents, such as culture solutions, and test methods
G. Sterility and method of measurement
H. Rapid measurement method for microbial leakage

3.2 Survey Concerning Standardization of Bioengineering

In June 1987, at the 13th Major Industrialized Nations Summit Conference (The Summit) held in Venice, Italy, Japan proposed "The Human Frontier Science Program" (Table 5), a large-scale international project systematically to clarify the excellent functions of human and other living organisms. In connection with this program, this survey aims to gather basic information necessary for the standardization of terminology and testing methods in bioengineering.

Specifically, standardization is scheduled for such key items as follow for the promotion of R&D in this field: standardization of concepts, terminology and symbols concerning the brain, the nerve system, heredity, generation, proliferation, differentiation, immunity, chemical responses, material substances, energy exchange, and their leading support

Table 1. Items To Be Standardized in Biotechnology Fields (48 items)[1]

Reagents, etc. to be standardized	Previous reference standard	Priority
1. Reagents:		
Glucose isomerase		A
Protease		A
Lipase		B
Cellulase		B
Urease		B
Glucose oxidase		B
Papain		B
Rennet		B
β-Amylase	JIS K 7001 (Industrial amylases)	C
Hesperidinase		C
Buffer solutions		A
Culture media		A
Restrictive enzymes		C
DNA ligase		C
Terminal transferase		C
Reverse transcriptase		C
Cell wall solubilizing enzymes		B
2. Apparatus and equipment		
Analyzer basic provisions	JIS K 0117 (Infrared spectrophotometry provisions), etc.	A
Apparatus and equipment basic provisions	Drug law (sterility, sterile operations) FDA, ISO 2037, ISO 2851	A
Bacteria filters	ASTM-F838-83, JIS Z 4812 (high function air filters for radioactive aerosols)	A
Gas sterilizers	Japan Pharmacopeia	A
Thermal sterilizers		A
Ultraviolet	JIS Z 8811 (Method of measuring sterilizing ultraviolet rays)	A
Radiation sterilizers		B
Sterile mechanical seals	JIS B 2405 (Mechanical Seal Provisions)	A
Safety cabinets	JIS B 9922 (clean bench)	A
Filter plugs for culture test tube		A
Air filter plugs for incubator		A
Petri dishes		A
Micropipettes		A
Centrifuges (including supercentrifuges)	JIS T 1701 (Medical centrifuges)	A
Electrophoretic devices		A
DNA synthesizers		B
Cell storage vessels		A
Clean benches	JIS B 9922 (clean bench)	A

[continued]

[Continuation of Table 1]

Reagents, etc. to be standardized	Previous reference standard	Priority
Liquid chromatography packings and columns	JIS K 0124 (high-speed liquid chromatographic analysis provisions)	A
Microfilters (MF film)		A
Dialysis membranes		A
Ultrafilters (UF film)		A
Ion exchange films		B
Reverse osmosis films (RO film)		B
Glucose sensor		A
Uric acid sensor		B
Urea sensor		B
Lactic acid sensor		B
Biosensor provisions		B
3. Others		
Terminology	JIS Z 8122 (Contamination control terminology)	A
Bio-experiment laboratory systems	Japan Clean Air Association Co., Ltd. (Guidelines for clean room operation and control)	A

Remarks: Priority ratings are as follows:

A: Production volume is comparatively large and standardization is desired soon.

B: Production volume is small, but standardization will be needed in the future.

C: Production volume is small, requiring many experiments, and standardization will be completed much further in the future as compared to B.

Table 2. Biotechnology-Related JIS Specifications Established in FY87

(1)	Glucose analyzers	JIS K 0701
(2)	Industrial glucose isomerase	JIS K 7002
(3)	Method of determining activity of industrial lipase	JIS K 0601
(4)	Plastic sterile Petri dishes	JIS K 0950
(5)	Autoanalyzer for total organic carbon (TOC)	JIS K 0805

(Established on 1 March 1988)

Table 3. Biotechnology-Related JIS Specifications To Be (tentatively) Established in FY88

(1) Biotechnology terminology
(2) Analytical methods for metals in high purity water
(3) Methods of counting the number of bacteria in high purity water
(4) Methods of measuring electric conductivity of high purity water
(5) Methods of determining total organic carbon in high purity water
(6) Membrane terminology
(7) Test methods for magnesium sulfate removal capabilities of reverse osmosis elements and modules
(8) Test methods for isopropyl alcohol removal capabilities of reverse osmosis elements and modules
(9) Standardization methods for water permeation capacity data for reverse osmosis elements and modules
(10) Dimensions of microfilters
(11) Test methods for diffusion flow of microfilters
(12) Test methods for bubble point of microfilters
(13) Test methods for initial flow of microfilters
(14) Test methods for relative resistance recovery capability of microfilters
(15) Test methods for potassium permanganate-reducing substances in effuse from microfilters for pharmaceutical manufacturing
(16) Test methods for bacteria screening capability of microfilters
(17) Test methods for endotoxin blocking ability of ultrafiltration modules
(18) Test methods for bacteria blocking ability of ultrafilters
(19) Test methods for aerosol screening ability of bacteria-screening HEPA filters
(20) Lactic acid analyzers
(21) Pushbutton type liquid microvolumeters
(22) Calibration methods for analytical liquid volumeters for chemical analysis

Table 4. Biotechnology-Related JIS Specifications To Be (tentatively) Established in FY89

(1) Test methods for chemical resistivity of microfilters
(2) Test methods for biological safety of microfilters
(3) Standardization methods for inorganic salt removal capability of reverse osmosis elements and modules
(4) Test methods for sodium chloride removal capability of reverse osmosis elements and modules
(5) Test methods for relative resistance recovery capability of ultrafilters
(6) Test methods for filtration capability of ultrafilters
(7) Test methods for aerosol screening capability of depth filters for air
(8) Culture media for tissue culture (minimal required media)
(9) Industrial amylases (revision)
(10) Plastic containers for storage of frozen cells
(11) Biochemical oxygen demand (BOD) analyzers
(12) Chemical oxygen demand (COD) analyzers for water quality surveillance

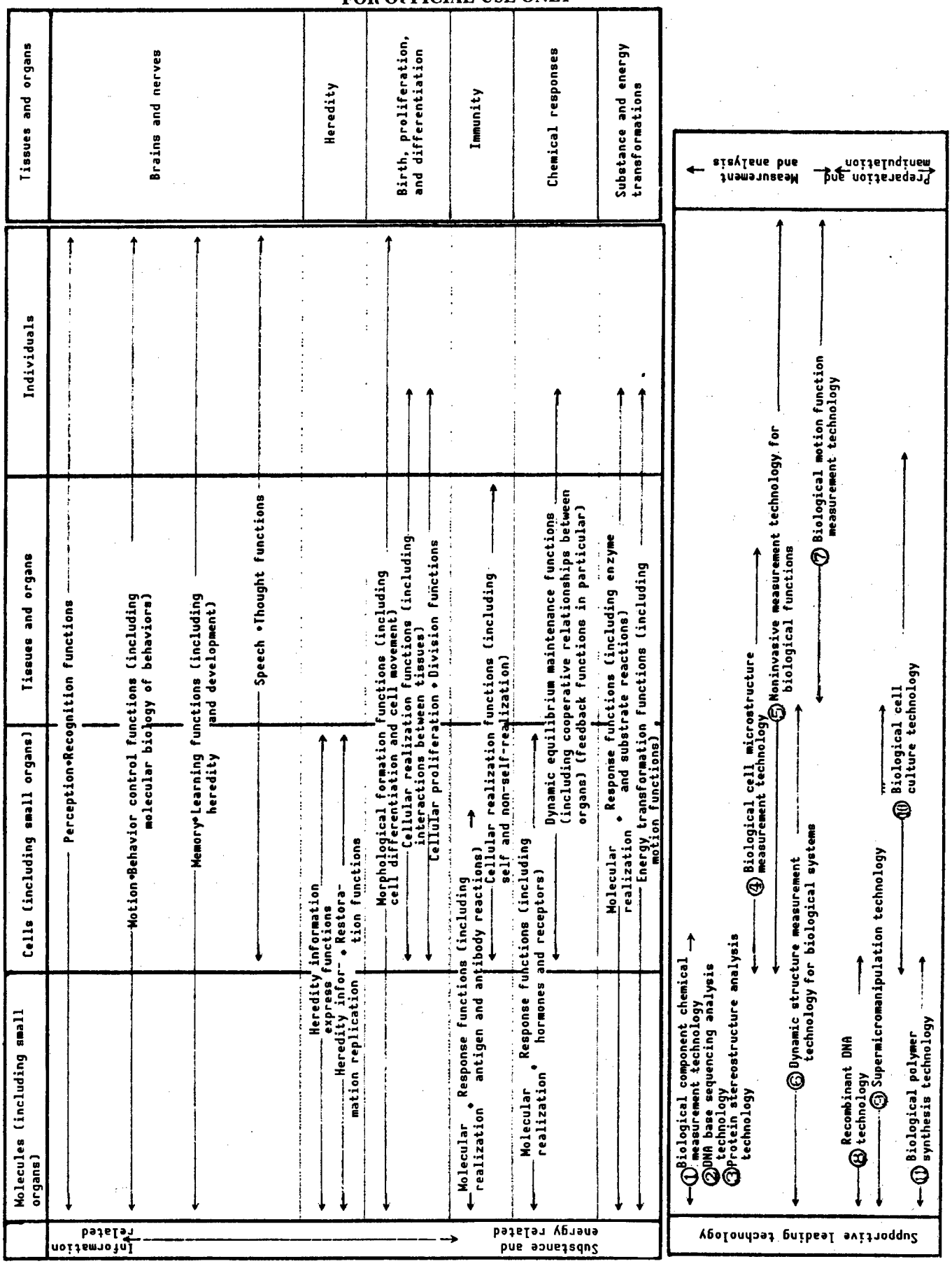
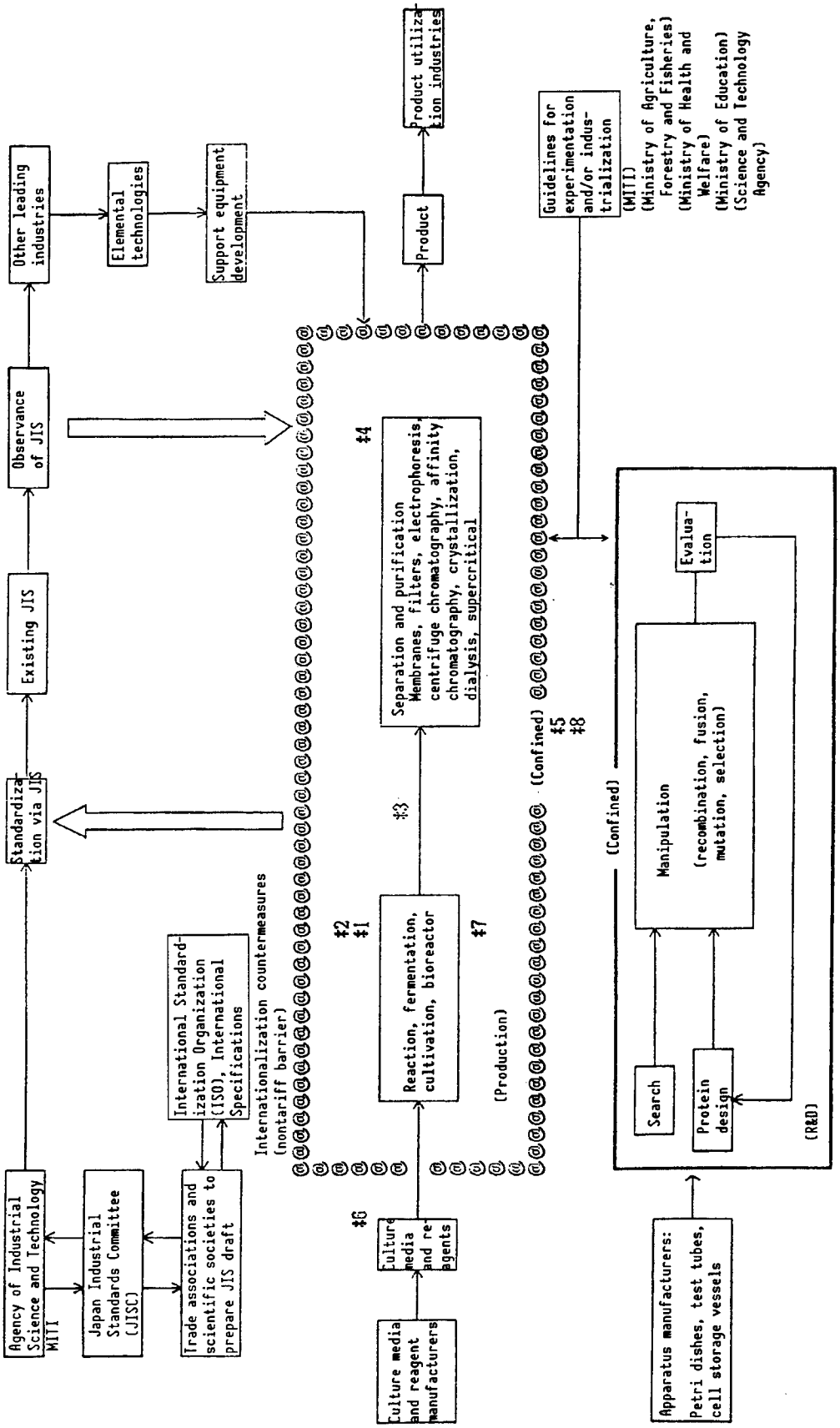


Table 5. Research Target Areas of the Human Frontier Science Program

Conceptual Diagram for Bioprocess Standardization



technologies; also protein measurement methods, test methods for artificial nerve elements, and computer graphic expression methods for protein stereostructures.

4. Need for Internationalization

It is thought that Japan must contribute internationally in the area of biotechnology standardization to expand international technical exchanges in biotechnology. However, for that purpose, cooperation among industry, academe, and government, and, in particular, a positive posture by industry are mandatory; greater cooperation in this matter is desired in the future.

Development and Standardization of Biotechnology-Supporting Apparatus and Systems, by Michio Okuma, Supervisor, Bioindustry Laboratory, System Business Department, Hitachi, Ltd.

1. Introduction

The object of this report is "machines and systems" within the "biotechnology-support industries" which support biotechnology. The realization that the quality of support apparatus and systems is vital to the progress of biotechnology industries has been growing. There have been surveys, research activities, and published reports. In addition, we have had inquiries and visits of study groups from overseas. The author's article, "Newest Technologies in Support of Biotechnology" was translated and distributed by France's National Science Research Center (CNRS). This is one indication of how strong overseas interest is in the apparatus and systems.

I would like to discuss the development and standardization of biotechnology-support apparatus and systems within the framework, illustrated in Figure 1, which has been constructed as a means to understand the relationship between biotechnology industries and biotechnology-support industries, as well as the technological relationship between biotechnology industries and their peripherally related industries. As we look at interindustry relationships within this framework, in view of the wide range of its applicable target areas and the greatness of its problem solving capabilities, new principle-based biotechnology is expected not only to develop biotechnology industries, in which biotechnology is directly applied, but also to change technologically the styles of other industries through permeation of its products. Among the biotechnology industry products which are expected to be used in other industries, are industrial raw materials, such as proteins, polysaccharides, and useful substances with complex chemical structures; enzymes, which act as biological catalysts in production processes; and antibodies, which have an affinity with high chemical selectivity. By using these products, chemical processes with enzymatic reaction at room temperature and pressure, efficient purification processes with antibodies, and the production of high quality products based on the supply of greater quantities of stable useful substances, should become feasible. Additionally, even the offer of a method to realize technologies, using biological disequilibrium and cooperative phenomena, becomes a part of the support region for biotechnology. It is also possible

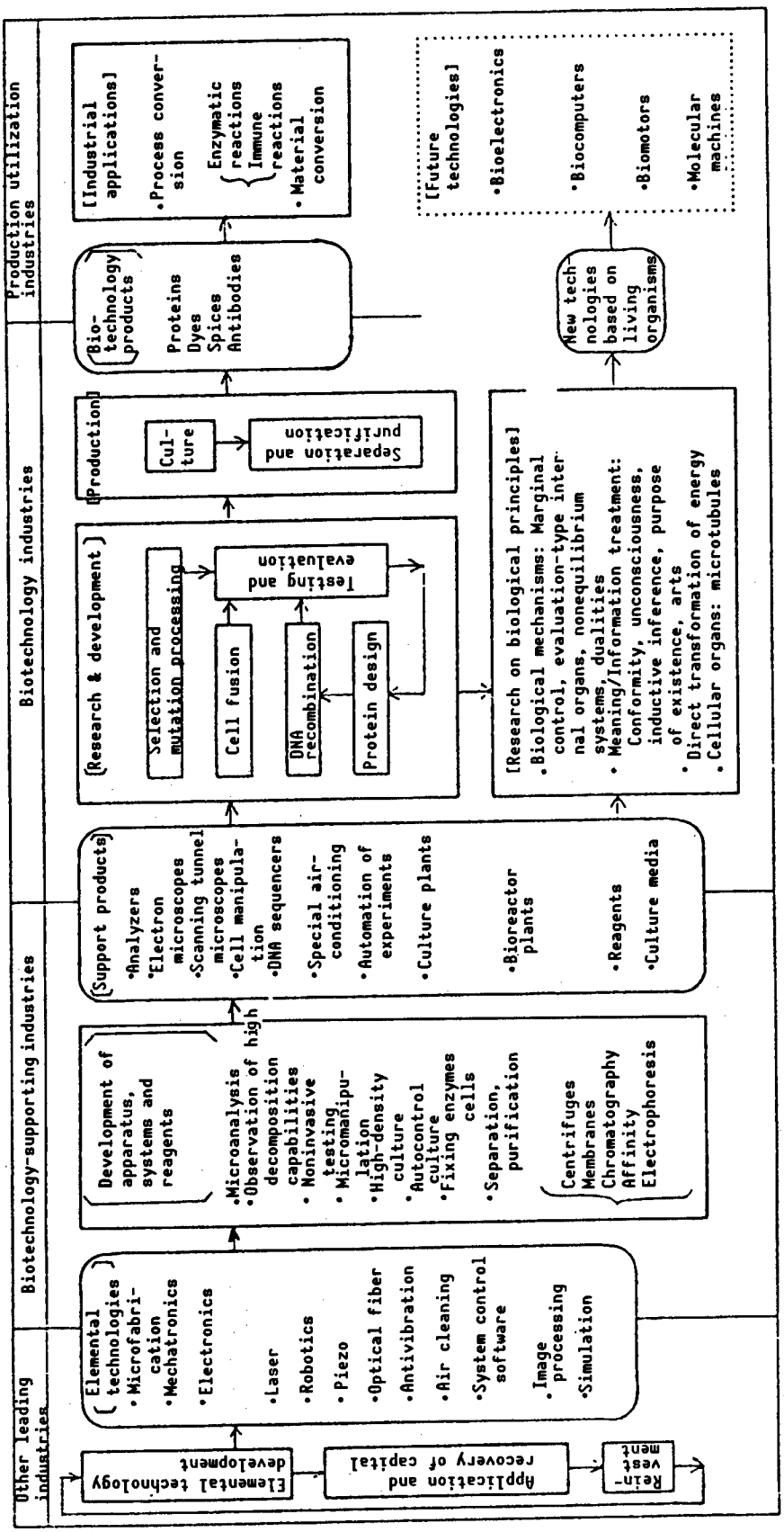


Figure 1. Relationships Between Industries and Technologies Connected With Biotechnology

to understand, from this framework, the importance of biotechnology-support industries and biotechnology's relationship with other leading technology industries in application of elemental technologies.

2. Issues Concerning Development of Support Apparatuses and Systems and Examples of Countermeasures

The DNA recombinant manipulation and cell fusion are the technologies which, after investigating nature at the cellular or molecular level, try to create a new organism by combining characteristics of two or more existing organisms. Protein engineering tries to cause an organism to manufacture a newly designed protein. Thus, today is the era of transition from "rearing and fabricating" technology to "creating" technology through biotechnology. Because biotechnology fields use newly developed bioscience, technical progress is fast, and, because it is the "creating" technology, the development competition is intense. Drastic acceleration to reduce the time span from R&D through production to the application of the fruits of development is desired, and apparatus and systems to support that must be improved. On the other hand, because many biotechnology industries will soon enter the production stage, there is a strong demand that the apparatus and systems used in the industries be supplied at low prices.

We must develop the support apparatus and systems with consideration of these two contradicting demands. Actually, however, to insure the demonstration of full capability and the priority use of researchers, we must first be able to cope with such issues as energy conservation, automation of routine operations, improvement of the speed of operation, and prevention of errors, and then we can realize products at low cost. For this type of development of apparatus and systems, the knowledge of living organisms is of course necessary, but also necessary is the technology to be able to manufacture apparatus and systems equipped with high functions at as low a cost as possible. Many apparatus and systems for biotechnology industries have been developed and improved strictly to improve their original technologies, but there are others that have used elemental technologies, developed by and giving satisfactory results to other leading technology industries. If one uses an elemental technology whose capability has already been confirmed through practical use, one can save the cost of developing the technology from scratch and can manufacture products which are thoroughly dependable from the beginning. The comprehensive capability, in a true sense, in the development of these apparatus and systems is how many kinds of elemental technologies that can withstand practical use, can one equip himself with. Indicated in Figure 1 are some of these elemental technologies, which are in use in other leading industries and also applied in the development of biotechnology-support apparatus and systems. To be able to use these elemental technologies efficiently, it is desirable to advance standardization with coordination among equipment as well as among related fields concerning the interface with automated systems.

Shown in Figure 2 is a simplified flow of biotechnology activities from DNA recombinant research through production. In addition to culture, destruction, separation, extraction, and analysis, the main unit processes include many processes unique to biological samples, such as sterilization,

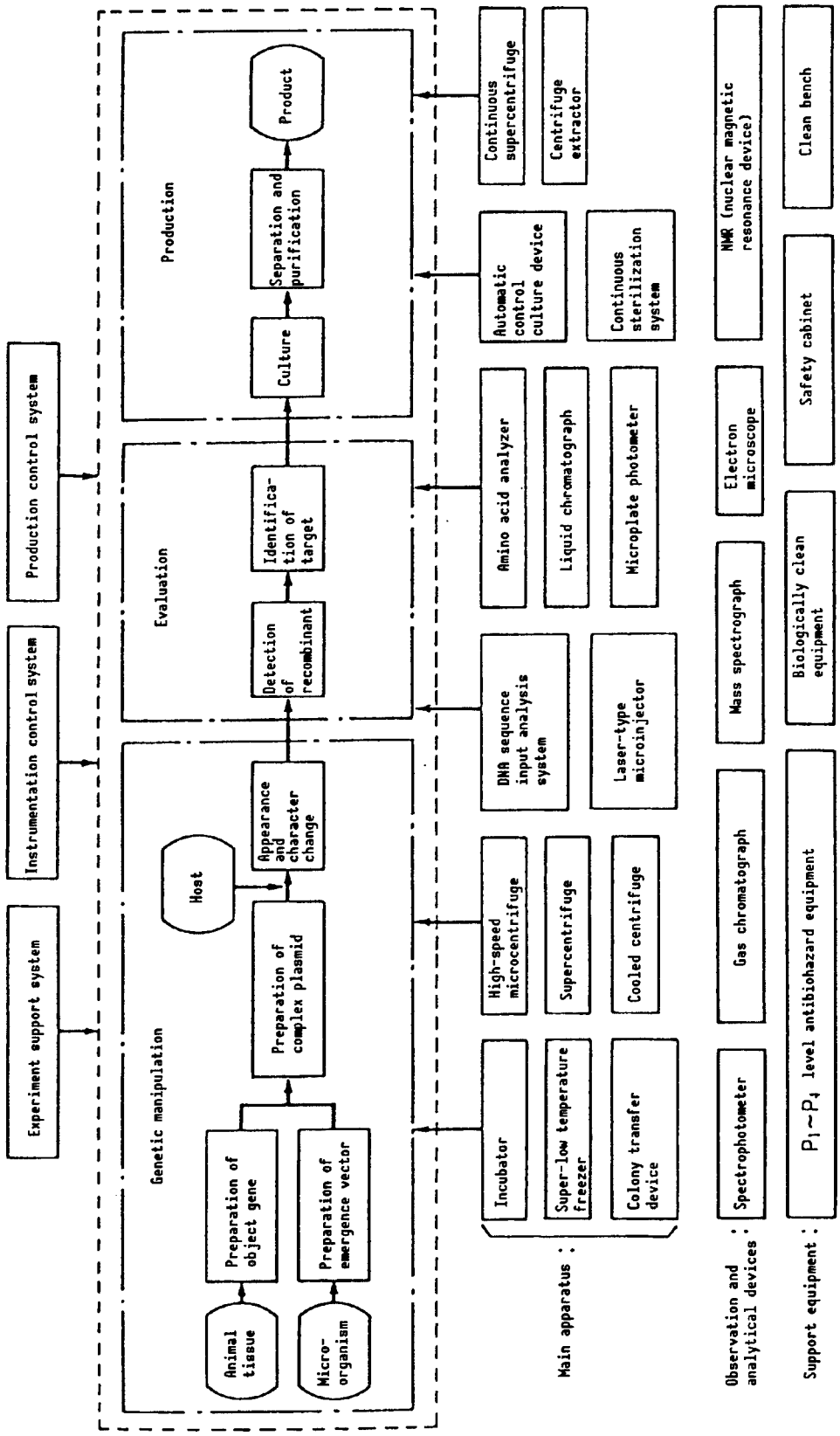


Figure 2. Research and Production System With DNA Recombinant Microbe

contamination prevention and elimination, and preservation. Figure 2 shows apparatus and systems and the corresponding stages in the flow at which they are used. Next, I shall analyze some examples selected from among the apparatus and systems which have been developed through the use of elemental technologies developed elsewhere.

(1) Colony Transfer Device

One of the important basic works in biotechnological research is to secure a highly active microorganism which coincides with the research objective. The work described below is being carried out to select one microorganism that fits the research scheme from naturally occurring microbes, or from those microbes which have received mutation treatment or DNA recombinant manipulation. A properly diluted solution containing a microorganism is sprayed over a flat kanten [agar-agar] culture medium in a petri dish, which is incubated in an appropriate environment to form a colony of microorganisms multiplied from identical parents and centered around a bacillus. Previously, observers of such colonies, judging from their color tone, shape, and size, manually selected and transferred them. Because so much valuable labor and time of researchers were wanted to do the work, the development of a device which automatically analyzes the appearance of colonies, selects, and transfers them was desired to save energy and to automate the operations. Upon analyzing the work involved, it was learned that both the petri dish and the semiconductor wafer were circular in shape with a diameter of about 10 cm, and they both underwent similar operations in dealing with micro-sized substances on their surfaces. Thus, such technologies as conveying, positioning, image processing, bonding, system control software, and clean space maintenance which had already been demonstrated successfully in a semiconductor manufacturing device, were applied to the movement and positioning of petri dishes, the analysis of color tones, shapes, and sizes of colonies on a petri dish, the three-dimensional movement operation of a transfer needle, the control of the total system, and the maintenance of clean environment. The applications resulted in a colony transfer device capable of operating many hours with reliability and stability. This device can automatically recognize the appearance of colonies in the source dish (the dish in which colonies have grown), automatically select a colony that fits a given set of conditions, and automatically transfer it to a specified position in the object dish (the dish to which a transfer is made) with high precision.

Initially, to screen natural organisms, the CT-2000 was developed to recognize, select, and transplant colonies using an ITV (industrial TV) color camera, next the CT-3000 was developed for monochrome recognition and mass transplant management. With mass continuous handling as the objective, the supply-demand volume of the disk is 504 sheets of the source. Further, to respond to the replication process, on the object side, it is a formula which is able simultaneously to set the dish which has four different selected cultures.

(2) Laser-Type Microinjector

The microinjection technology to insert a foreign gene into a culture cell is one of the useful tools for research and development in an attempt to clarify biological mechanisms and to manufacture useful products. It is widely used in such industries as agriculture, cattle, pharmaceutical manufacture, chemicals, and food fabrication. The Institute of Physical and Chemical Research developed a new, extremely efficient laser method for gene insertion. Hitachi, Ltd., then licensed the technology to develop the commercial product, laser-type microinjectors.

There were other methods to insert genes into a cell: one to chemically treat the cell wall to make it more penetrable for insertion, and another to manipulate a microneedle under a microscope for insertion. There were problems with these methods, as they not only required expertise and considerable labor but also tended to lower the emergence efficiency due to cell damage. The laser-type device solved these problems and was able to improve significantly the operability, processing speed, and manifesting efficiency.

In this device the working laser and the pilot laser are coaxial to make the irradiation spot visible, and the beam converges with the objective lens to irradiate the living cell to open a minuscule hole. The sample cell is in contact with a culture solution containing genes so that as soon as the hole is created in the cell wall by laser, the genes in the solution are taken inside the cell. The drilled hole then rapidly restores itself. There are two modes in the laser irradiation method. One is called the pointing mode thereby cells are depicted on a television monitor, desired irradiation spots are marked with a light pen, and each cell is irradiated accurately. The other mode is called the scanning mode whereby laser is emitted at a constant pulse, and an X-Y stage on which the sample is mounted is moved to a constant speed to cause the laser to irradiate in a high-speed scanning fashion.

(3) Automatic Control Culture Device

The production capacity of each individual cell cannot be changed when causing genetic recombinant microbes to produce a target substance. To increase production efficiency, it is necessary to increase the bacteria concentration in the culture solution and to perform at the proper time some sort of emergence induction operation depending on the type of promoter (specific sequence in DNA to initiate the emergence of genes) that is used. Therefore, more sophisticated technologies than ever before are required for the culture.

However, it is difficult to handle because the proliferation and substance production of microorganisms are governed by many factors, and the most important controlling factors, such as the microbial concentration and product concentration, are difficult to determine in an on-line, real-time fashion. For that reason, biological reactions, such as microbial proliferation activity and metabolic production volume, are being analyzed in detail and examined as important corresponding technologies. A high

density automatic control culture device was developed based on the optimal control method in the culture of yeast or genetically recombinant coliform bacilli. In addition, data are being compiled for the establishment of a sophisticated culture technology for the culture of genetic recombinant bacteria or animal and plant cells.

Because we are here dealing with objects which are biological systems consisting of nonequilibrium, nonlinear-type aggregates, we cannot perform accurately with linear approximation or simple automation. For the construction of a culture plant, tests with a commercial experimental apparatus are frequently used to develop control software after confirming the proliferation of a microbe and the production of a target substance and understanding their characteristics through preliminary culture tests. For software, the adaptation for an Expert System had been attempted, and the subject was taken up by the recent symposium on "The Automation and Intellectualization of Bioprocesses." In the symposium, requests were made to use knowledge inductively integrated from knowledge gathered through knowledge acquisition, but the computer software group expressed its view that it would be difficult to carry out the inductive processing of information with currently available computers. Thus, as the next best scheme, the use of knowledge which had been developed deductively from scientific laws was suggested. Here, scientific laws signify phase rules, thermodynamics laws, and the development of "swing" in a nonlinear system. They are considered the result of information compression of nature's physical and chemical characteristics.

(4) Environmental Control System

In experiments with tissue culture or cell culture, bio-clean rooms and clean benches are used to prevent contamination by airborne foreign microbes. Recently, through exchanges between the technology to clean air, such as the laminar flow formation and filtration of air, and the special air-conditioning technology used in the semiconductor manufacturing process, both of these technologies have improved.

To improve the efficiency of plant research, phytotrons (plant environmental test devices), growth chambers, and plant acclimation devices have been developed. These are systems by which any environment conditions to suit research purposes can be created by automatically controlling such conditions as air flow, lighting, temperature, and humidity, taking advantage of environmental technologies, such as air-conditioning and dust collecting, and computer-applied control technology.

In plant tissue culture work, called [MERIKURON], the collection of growth points is conducted in a clean bench and the culture processes are carried out in a clean environment. By acclimating seedlings grown in an artificial environment prior to planting in paddy fields, the yield of healthy seedlings has improved.

3. Issues Concerning Standardization

It is said that biotechnology industries are moving into the manufacturing stage. Any new function-equipped biotechnological products, if they can demonstrate those targeted capabilities, should naturally be accepted as a commercial product. That has been proven by the growth in the last 2 to 3 years of the commercialization of diagnostic drugs. If biotechnological industries enter the manufacturing stage, make a profit, and reinvest a part of the profit, then it is expected that the demand for the apparatus and systems will expand. The resource allotment by the equipment manufacturer to the development of biotechnological apparatus and systems will increase, and, in turn, the possibility to develop and/or improve new equipment will become greater. To prepare for that situation and to achieve industrialization in an organized fashion, an attempt to establish JIS for biotechnology is being made after the suggestion by Chairman Suzuki of the Biotechnology Special Committee, JISC, to proceed with the standardization as the first step. Also, a separate survey has been conducted by the Bioprocess Standardization Feasibility Survey Committee (chairman: Takahisa Ota), as commissioned by the Agency of Industrial Science and Technology (AIST). I shall discuss several issues involved in the standardization of the bioprocess off-line instrumentation equipment which have evolved during the survey.

Because the bioprocess deals with so many different types of objects, such as various kinds of cells, proteins, and secondary metabolites, it uses wide-ranging equipment with wide-ranging requirements for characteristics and materials. Examples of equipment are listed below.

- Pretreatment Devices: samplers, cell smashers, homogenizers, centrifuges, ion exchange columns, filters, separatory chromatographs, pretreatment automation (laboratory robots, cylindrical coordinate systems, and perpendicular coordinate systems), safety cabinets, clean benches, incubators, vibrating incubators, and high-pressure steam sterilizers

- Analyzers: pH meters, glucose analyzers, amino acid analyzers, liquid chromatographs, affinity chromatographs, refractometers, viscosimeters, spectrophotometers, gas chromatographs, electrophoretic apparatus

- Apparatus: pushbutton-type liquid micropipettes, stirrers, heaters (water baths, metal blocks), discoloring agents, reagents, solvents, analytical standards

According to the book, "Japan's Industrial Standardization," edited by AIST, the purposes of the current standardization are: 1) mutual understanding; 2) safety, health, and environment; 3) common feature and interchangeability; 4) compatibility with use objective; and 5) limitation on varieties.

The standardization needs to move forward in reference to these purposes. The following are a summary of standardization issues common to all the above-listed examples.

a. Performance:

• Is specified quantity of material or energy supplied correctly? (Adhesion to the point of an injection needle, dead space, adsorption to liquid-contacting surfaces, temperature uniformity, supersonics, and torque)

• Range capabilities of analyzers

• Countermeasures against negative situations (countermeasures and regulations against and indications of loss of control of temperature, noise level, misting, and heating)

b. Material quality:

• Adsorption, hydrophobicity, hydrophilicity, electric surface potential (filter, discoloring and tubing materials)

• Degree of purification (column packing material)

• Insulative characteristics (air permeability and elasticity)

c. Operation

• Automation and material selection to suit experience of operator (safety guarantee and problems of maintenance/corrosion)

• Interchangeability (liquid chromatography, centrifuge, "connection" between automated lines)

d. Response to new product and/or new use:

• New method (cell smashing/suspension jet)

• New use (viscosimeter/feed-batch culture)

e. Others:

• Because of the improvement in the concentration by liquid chromatography and the sensitivity of analyzers, microquantities of fluorescent substances in solvents, microquantities of impurities in pure water, and even organic residues adhering on test tubes have begun to cause problems.

4. Future View

A committee of BIDEC (Bioindustry Association) published a report on the future outlook for biotechnological supportive apparatus and systems. It discusses the technological analysis of the living body, future images of living species, and apparatus and systems. It points out that the following fields and equipment should draw attention because of expected future

progress: the design of proteins (protein engineering), the use of the minimally required portion of biological materials, the stabilization mechanism of biological systems, and the cranial nerve system as target fields; nonaqueous bioreactors, noninvasive instrumentation, affinity chromatography, animal cell culture to approach the cell density level equal to the density in the living body, the light-independent nutrient culture of plants, and optical fiber-applied sensors. With any of these items there are problems to be overcome by future development. However, if realized, they are expected to contribute significantly. As we push forward to achieve standardization, these are good reference points for our long-range planning.

Standardization of Key Biotech-Related Technologies and Its Prospects--Automation and Intellectualization of Bioprocesses, by Isao Endo, Chemical Engineering Laboratory, Institute of Physical and Chemical Research

1. Introduction

Not just bioindustries but all industries in Japan today confront an extremely severe social environment. For instance, there is the world economy, the increase of aged workers, the increase of female workers, informationization, and the technological revolution. These environmental elements, while affecting each other, are undermining current society.

The purpose of this brief presentation is to discuss why the automation and intellectualization of bioprocesses are necessary with the background of the above-mentioned social environment. During the course of the discussion, I would like to point out the importance of the standardization of key biotech-related technologies, i.e., the standardization of bioprocess-related drugs, apparatus, devices, and measurement methods.

2. Social Environment Surrounding Bioindustries

Many mass media are reporting in detail the current social problem confronting Japan. When these problems are sorted from the industrial standpoint, we have, as pointed out earlier: 1) the world economy; 2) the increase of aged and female workers; 3) informationalization; and 4) technological revolution.

"World economy" means that the Japanese must sincerely realize the position and the role of Japan's economy within the world economy in the flow-and-stock of materials, such as money, raw materials, products, energy resources, and information. In 1979, OECD announced its forecast for the near future through the year 2000 and four scenarios for the new world order. The scenarios are: 1) advanced industrialized nations continue fast growth; 2) advanced nations continue slow growth, such as in the post oil-shock era; 3) the north and the south are disunited; and 4) major advanced nations assume new protectionism and tripolar monetary systems are realized.

For each of the scenarios, swings of GNP per capita in various regions were examined. Nishikawa's view is, "Perhaps it will be desirable for the more

peaceful world of the 21st century to move toward a loose world federation via the tripolar independent systems."

In this process of transition of the world economy, Nishikawa lists Japan's projects as follows: 1) to increase domestic demand through the combination of the expansion of national life-related social overhead capital, the increase of real wages, and the reduction of working hours; 2) to develop and revitalize local areas; 3) to strengthen human rights; and 4) to strengthen pacifism and antinuclear movement.

Strengthening human rights, as Nishikawa pointed out here, contains extremely complex problems. As I discussed in the beginning of this paper, the increases of aged and female workers are naturally related to the strengthening of human rights. Right now, I choose very simply to discuss aged and female workers.

I believe that in the future, Japan's industries cannot ignore the wisdom and knowledge of the aged nor the sensitiveness and perseverance of women. Conversely, the aged lose reflex and athletic capabilities. Women are apt to spend too much time making up their minds because they worry about too many things. To realize the automation and intellectualization in the industrial workplace by maintaining their strengths and improving their weaknesses, it will probably be more necessary than ever to develop an expert system including intelligent robots, operation support, and decision making support.

Next, I will discuss informationalization. Informationalization is the transition of a society toward the following situations: 1) "the industrialization of information" represented by news media and the data base; 2) "the informationalization of industries," such as office automation and factory automation; 3) "the informationalization of individuals and households," such as home security and home shopping; and 4) "the informationalization of society," such as government information services.

This presentation's main topic, the automation of bioprocesses, is closely connected especially with "the informationalization of industries." In other words, both informationalization and to-be-discussed technological revolution will certainly promote interindustrialization by removing the previous barriers between primary and secondary industries.

Technological revolution is not limited to biotechnology. It is the revolution of products, processes, and management in many fields called pioneering technologies, such as material engineering, computer technology, and communications technology. These technologies, while having ripple effects on each other, are gradually affecting a business upturn in the world economy. As far as the relationship between business fluctuations and technological revolution in the world economy, please refer to the commentaries by Uchida and Katsura. For the technological revolution in biotechnology, please read my comprehensive commentary.

3. Automation and Intellectualization of Bioprocesses

The "automation" here does not mean the "automation," as previously used, in the mass production of a few products to pursue economy of scale. It may be said that the "automation" in the traditional sense has been completed in almost every industry with the progress of computers.

Today, the market demands multiproduct small volume production as well as multiproduct mass production. For an enterprise to respond to such market demand and to survive, there is no doubt that it must improve its previous production system. Awane points out the following policies: 1) the reduction of indirect cost; 2) the reduction of direct cost (products, labor, and parts); 3) the reduction of delivery time (the increase of gross sales); and 4) the increase of sales price.

The relationships of these policies to the rationalization objectives are illustrated in Figure 1. In the 1960s business effort was mainly directed from production averaging to parts standardization; in the 1970s it was from equipment automation to the improvement of inventory accuracy. Awane has predicted that in the 1980s the business rationalization will advance from mixed production to new product exploitation, and he is about right.

The very technologies demanded during the course of these industrial efforts are factory automation (FA), the flexible production system (FMS), robotization, and the movement toward CAD/CAM/Database. Also, not only "automation," but the intellectualization of processes (expert system, learning technology in Figure 1) is also demanded.

Let us turn to bioindustries. Needless to say, the foundation of bioindustries lies in bioprocesses in the production line. Bioprocesses are: 1) raw materials storage and preparation processes; 2) bioreactor processes; 3) product isolation and purification processes; 4) environment preservation processes; and 5) evaluation processes, which inspect and control all the above process systems.

Here, bioreactor is the technology that produces, by the processes, medical treatment and welfare, foods, resources and energy, drugs and agriculture chemicals, industrial chemicals, and environmental preservation. In this process, the technology starts the production with such inputs as raw materials, energy, management and market information, and uses various biological materials (biological elements), such as animal and plant tissue cells, industrial use microorganisms, enzymes, biological membranes, artificial enzymes, and artificial cells. In particular, the fact that various functions of biological materials can be modified or improved at will at the gene level, is the reason why it is called revolutionary technology. That concept is diagrammed in Figure 2.

To automate the above-mentioned bioprocesses, one must first of all think about the clarification for the framework of a process system. Naturally, the framework varies depending on the type of product, the biological materials to be used, raw materials, energy, and market information, but our discussion cannot begin without establishing the framework.

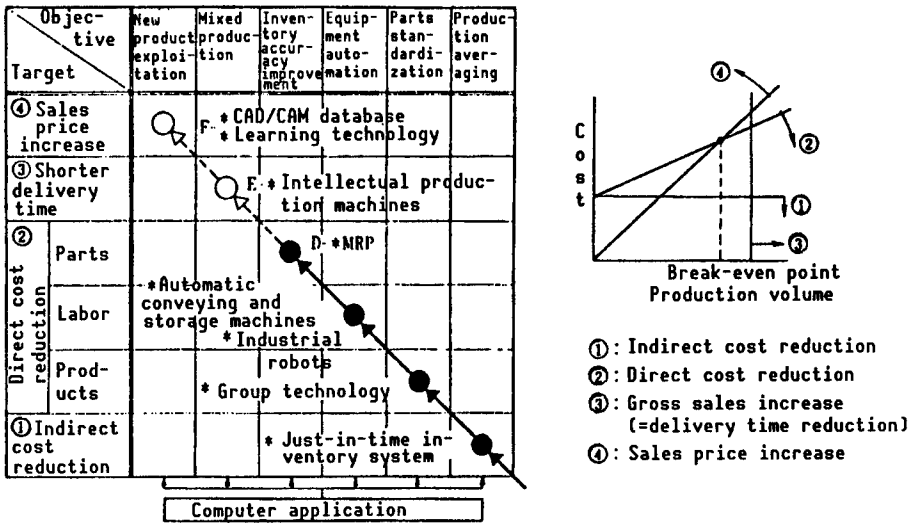


Figure 1. Production System

B	Direct cost (product) reduction	Parts standardization	Group technology
C	Direct cost (labor) reduction	Equipment automation	MH/storage/robot
D	Direct cost (parts) reduction	Inventory accuracy improvement	MRP
E	Product lead time reduction	Mixed production	Production machine intellectualization/ robotization
F	Gross sales increase	New product exploitation	CAD/CAM database/ learning technology

Figure 4.5 Rationalization Objectives and Tools for 1980s

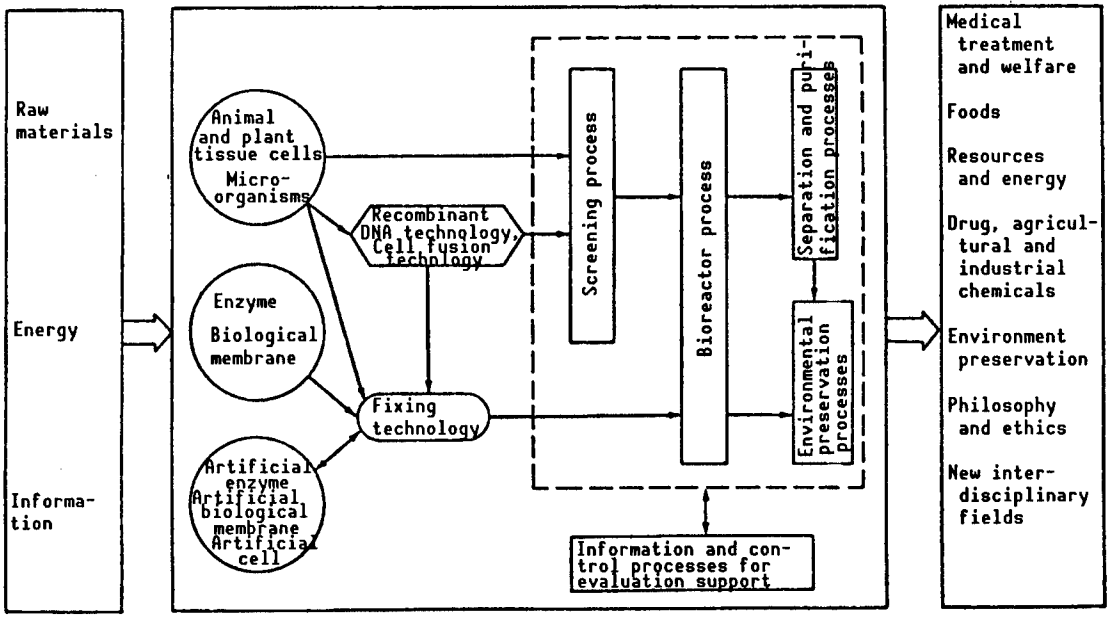


Figure 2. Conceptual Diagram of New Biotechnology

Secondly, process variables and control variables must be determined. In other words, one must ask oneself what must be measured to check correctly the state of a process and what must be controlled so that a process can be manipulated normally and safely. For example, in a bioreactor process mainly involving fermentation, the author and his colleagues thought that variables listed in Table 1 should be determined and controlled, and eventually developed an automatic monitor-control system, which does just that.

When you glance through Table 1, you will probably come up with many questions, such as why those variables are targeted, what kind of capabilities do those sensors possess, and how long they can be used. In fact, answers to these questions are the standardization of bioprocesses. In 1987, as commissioned by the Textile Chemical Specification Section, Standards Department, Agency of Industrial Science and Technology, MITI, "Survey Committee Concerning Standardization of Bioprocesses" (chairman, Takahisa Ota, professor, Tokyo University) was inaugurated. The committee is conducting survey research for the standardization for the following eight items: 1) interchangeability of management instrumentation and devices for process control, e.g., biosensors; 2) interchangeability of enzyme fixing agents; 3) rapid, automatic physical property measurement methods; 4) rapid determination methods for separation and purification capabilities; 5) standardization and measurement methods for airtightness; 6) standardization and measurement methods for bioprocess reagents such as culture solutions; 7) standardization and measurement methods for sterility; and 8) rapid measurement methods for microbial leakage.

Let us now go back to our main topic. The author thinks that the most serious bottlenecks for the automation and intellectualization of bioprocesses are the lag in the characterization of biological materials as well as the conversion of that information into database. Here, data mean, not the literature, but the type of data expressed in numerical values or as pictorial images. They are the data which users can access freely in real time at any time and at any place. These are called fact data.

They are, for all bioprocesses: 1) data on raw material for the preparation of culture media; 2) data to diagnose any process abnormalities; 3) data to allow feed-forward control of separation and purification processes; 4) data for production control, such as a production plan, a loading plan, and an operation plan; and 5) data for production cost control and quality control.

A system that receives and controls such fact data on bioprocesses is called a bio-database.

To promote the standardization of bioprocesses, an expert system is required which allows the active use of such databases on the production floor. As I have already mentioned repeatedly, in bioindustries, where the objective is multiproduct small-volume production or multiproduct large-volume production, the previous rigid, program-regulated production system is no longer important. Rather, it is important to have flexible operation and

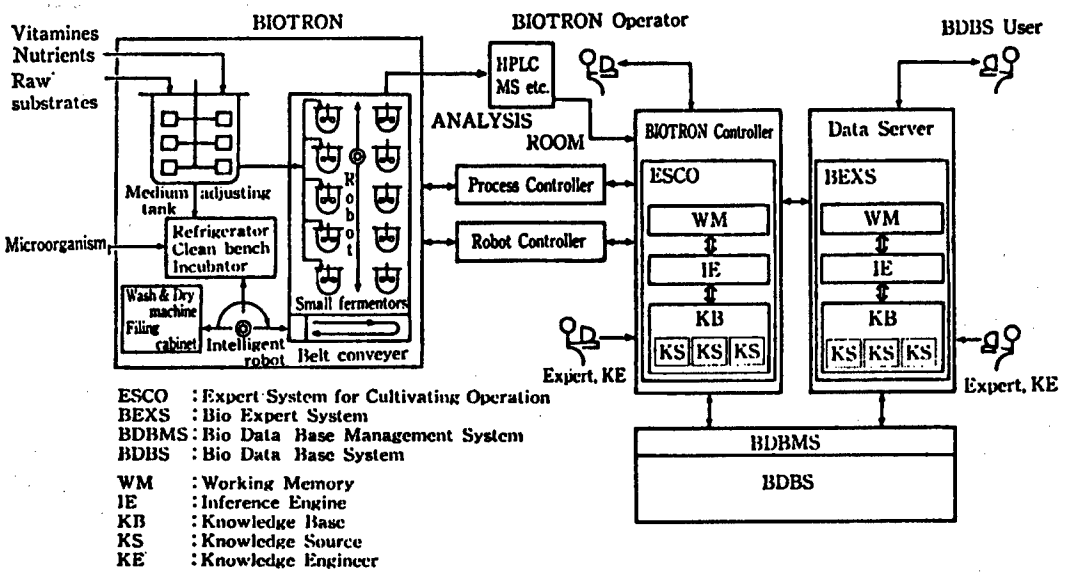


Figure 3. Concept of Biodatabase System (BDBS) and Expert Systems (ESCO & BEXS)

Table 1. Standardization of the Bioprocess Parameters for Monitoring

	Items	Commonly used system	BIOACS
Monitoring	Temperature	○	○
	Pressure	○	○
	pH-value	○	○
	D. O.	○	○
	Airation rate	○	○
	Agitation speed	○	○
	pO_2 in	○	○
	pO_2 out	○	○
	pCO_2 in	○	○
	pCO_2 out	○	○
	Working volume	○	○
	Torque	○	○
	Turbidity	×	◎ on-line
	Product concentration	×	◎ on-line
	Substrate concentration	×	◎ on-line
	Specific rates	×	◎ on-line
Controlling	Temperature	○	◎ optimal control
	Pressure	○	○ setpoint control
	pH-value	○	◎ optimal control
	pO_2 in	○	○ setpoint control
	Airation rate	○	○ setpoint control
	Agitation speed	○	○ setpoint control
	Feed rate	○	◎ optimal control

manipulation of processes by making good use of the experience and wisdom of skilled workers on the production floor.

Illustrated in Figure 3 is the conceptual diagram covering both database system and expert system which we have been considering. Our system consists of the biotron as a fact generator, the analytical laboratory, the biological reaction operation supportive expert system (ESCO) to supervise and control the analytical laboratory, the expert system (BEXS) to support or diagnose abnormality of running and handling of a factory, and the bio database system (BDBS) to store all fact data and past records.

Part II (6 April 1988)--Technical Trend of JIS Establishment and Summary of Analytical Chemistry Department Meetings, by Suichi Suzuki, Professor, Saitama Institute of Technology, and Professor Emeritus, Tokyo Institute of Technology

1. Need for standardization
2. Examples of equipment used in recombinant DNA research
3. Examples of equipment used in cell fusion research
4. Examples of equipment used in cell culture research
5. Biotechnology-related items to be standardized
6. Problems of biotechnology-related JIS specifications
7. Outlook for future research topics

The need for standardization

Simplification: form, size, and grades for materials, parts, and products--specifications

Specialization: limitation of varieties, production, and supply process--distribution rationalization

Technologies under development--guidelines for basic items

Draft preparation--information collection and revision

The objectives of items

Basic items

Use frequency

1) Enzymes: production volume, activity evaluation method
2) Equipment: capability evaluation
3) Laboratory system: environmental safety
4) Terminology

Approaches to establishment of specifications

1) Active use of available data and actual results
2) Unpublished data--survey research

3) Incomplete technologies--data collection--framework building--revision

Examples of equipment used in recombinant DNA research

(1) Cell smasher

(2) Sterilizer, cooled centrifuge

Chromatographic separation device
Electrophoretic device
UV-lamp photographic device
Densitometer

(3) Constant temperature layer

High-speed microcentrifuge
Density gradient preparation separation device
Liquid scintillation counter
Deep freezer

(4) Incubator

(5) Supersonic smasher

(6) Safety cabinet

(7) Turntable

(8) Amino acid analyzer

High-speed liquid chromatograph

(9) Nucleic acid synthesizer

(10) Electron microscope

(11) Jar fermenter

Continuous centrifuge

Examples of equipment used in cell fusion research

(1) Autotable

Heated vibrating incubator
Cold box
Carbon dioxide incubator

(2) Phase contrast microscope

(3) Turntable

(4) Agar plate preparation device

(5) Colony counter

(6) Affinity chromatograph

Fluorescence spectrophotometer
GC-MS
NMR
IR

Examples of equipment used in cell culture

(1) Clean bench

Freezer
Cell filtration device
Equipment cleaning device

(2) Multitray culture device

Constant temperature incubation room
Micromanipulator

(3) Tank culture device

(4) Cold room

Gas chromatograph
Fraction collector
Freeze-dryer

(5) Revolving vibrating incubator

Instrumentation system

Table 1. Biotechnology-Related Items To Be Standardized

1. Reagents

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Glucose isomerase	Enzyme, microbe-applied technology		A	Impurities, activity, half-life, activity measurement method, item to be indicated (supply source, type of carrier, use conditions, and activity)	Mainly by using previous data
Protease			A	Impurities, activity, activity measurement method, storage method, items to be indicated (supply source, use conditions, and activity)	Broad survey research is necessary
Lipase			B	Same as above	Same as above
Cellulase			B	Impurities, activity, half-life activity measurement method, storage method, items to be indicated (supply source, carrier type, use conditions, and activity)	Same as above
Urease			B	Same as above	Mainly by using previous data
Glucose oxidase			B	Same as above	Same as above
Papain			B	Impurity, activity, activity measurement method, storage method, items to be indicated (supply source, use conditions, and activity)	Same as above

[continued]

[Continuation of Table 1]

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Rennet			B	Same as above	Broad survey research is necessary
β-Amylase		JIS K 7001 industrial amylase	C	Same as above	Mainly by using previous data
Hesperidinase			C	Same as above	Same as above
Buffer solution	Artificial mutation-applied technology		A	pH range, effectiveness, storage method, and items to be indicated	Same as above
Culture medium			A	Components, storage method, and indication items	Same as above
Restrictive enzyme	Recombinant DNA-applied technology		C	Impurities, activity, activity measurement method, and indication items (supply source, use conditions, activity)	Broad survey research is necessary
DNA ligase			C	Same as above	Same as above
Terminal transferase			C	Same as above	Same as above
Reverse transcriptase			C	Same as above	Same as above
Cell wall-solubility enzyme	Cell fusion technology		B	Purity, activity measurement method, activity indication method, and storage method	Same as above

[continued]

[Continuation of Table 1]

2. Apparatus and Devices

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Basic provisions for analyzers	Common	JIS K 0017 IR spectrophotometer provisions	A	Types of analyzers, capabilities (scope of measurement, reproducibility, zero drift), design, calibration, and maintenance storage	Mainly by using previous data
Basic provisions for equipment		Pharmaceutical Affairs Law (sterilization, manipulation, FDA, ISO-2037, ISO-2851	A	Structure of connecting parts such as tubing, dimensions (interchangeability, tamari)	Same as above
Microbial filters		ASTM-F-838-83, JIS Z 4812 (high-capacity air filter for radioactive aerosol)	A	Outer dimensions, specified flow volume, collection efficiency, initial pressure loss, pressure deformation, airtightness, microbial removal efficiency, and filter pore diameter	Broad survey research is necessary
Gas sterilizers		Japan Pharmacopeia	A	Form, sterilization mode, use temperature and humidity, reagent concentration and pressure, and construction material for pressure vessel	Same as above
Thermal sterilizers			A	Form, sterilization mode, use temperature, pressure, and high pressure safety device	Same as above

[continued]

[Continuation of Table 1]

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
UV sterilizers		JIS Z 8811 (Sterilizing UV measurement method)	A	Form, dimensions, applications, structure, irradiation time, irradiation distance, UV intensity, and sterilized effects	Same as above
Radiation sterilizers			B	Form, dimensions, applications, structure, safety, radiation dosage, time, and sterilization effects	Same as above
Sterile mechanical seals		JIS B 2405 (Mechanical seal provisions	A	Sealing method, leakage, stability, against motion, structure, and dimensions	Same as above
Safety cabinets		JIS B 9922 (Clean bench)	A	Airtightness, exhaust mode, dimensions, cleanliness, and type of filter	Same as above
Filter plugs for culture test tubes			A	Dimensions, construction material, ventilation level durability, temperature, life, and cleanliness	Same as above
Air filter plugs for incubators			A	Same as above	Same as above
Petri dishes			A	Dimensions, construction material, durability, and temperature	Mainly by using previous data
Micropipettes			A	Form, structure, fractional addition volume, addition precision, reproducibility, materials for construction, and indications	Broad survey research is necessary

[continued]

[Continuation of Table 1]

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Centrifuges (and supercentrifuges)		JIS T 1701 (Medical centrifuge)	A	Structure, dimensions, capability, and indications	Same as above
Electrophoretic devices			A	Electric source part (output stability, antiexplosion structure that can go in and out of low-temperature room), electrophoretic bath (size, thickness, gel material, preparation method, and ready-made gel	Mainly by using previous data
DNA synthesizers	Recombinant DNA-applied technology		B	Yield at each step, required amount of reagent, reagent stability, and purity of synthesized DNA	Broad survey research is necessary
Cell storage vessels	Large volume cell culture technology		A	Freeze-use culture medium, construction material of vessel, structure, and method if freezing	Mainly by using previous data
Clean benches		JIS B 9922 (Clean bench)	A	Sidewall material, air filter, and structure of exhaust system	Broad survey research is necessary
Packing materials and columns for liquid chromatography	Separation and purification technology for microquantity biological materials	JIS K 0124 (HPLC analysis provisions)	A	Type, applications, particle size, particle size distribution, column dimensions (inner diameter, length), elution method or screw dimensions, column capabilities (number of theoretical steps, critical molecular weight for elimination)	Same as above

[continued]

[Continuation of Table 1]

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Micro-filters (MF) membranes)			A	Material, shape, dimensions; and membrane performance (water diffusivity, pressure resistance)	Same as above
Dialysis membranes			A	Material, shape, dimensions, thickness, and membrane performance (segregating molecular weight, diffusion coefficient)	Same as above
Ultra-filters (UF membranes)			A	Material, shape, dimensions, and membrane performance (segregating molecular weight, water diffusivity, separation ratio, pressure resistance, and chemical resistance)	Same as above
Ion exchange membranes	Separation and purification technology for micro-quantity biological materials		B	Material, shape, dimensions, and membrane performance (type of exchange radical, charge density of exchange radical, tensile strength, ring ratio, and diffusion coefficient	Same as above
Reverse osmosis membranes (RO membranes)			B	Material, shape, dimensions, and membrane performance (diffusion coefficient, separation ratio, pressure resistance, chemical resistance)	Same as above
Glucose sensor	Biosensor technology		A	Response sensitivity of device system, response time, selectivity, use life, and use conditions (solution, sample)	Mainly by using previous data

[continued]

Continuation of Table 1]

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Uric acid sensor			B	Same as above	Broad survey research is necessary
Urea sensor			B	Same as above	Same as above
Lactic acid sensor			B	Same as above	Same as above
Biosensor provisions			B	Method of construction (adhesivity between film and electrode), structural factors (fixing film)	Same as above

3. Others

Target for standardization	Main application technology field	Available reference standard	Priority	Main specification items	Draft preparation method
Terminology		JIS Z 8122 (Contamination control terminology)	A	Terminology for enzyme activity, substrate properties, fixing method, fixing yield, relative activity, biosensor, safety cabinet, clean bench	Mainly by using previous data
Biolaboratory system	Environment	Japan Clean Air Association Co. (Guidelines for clean room operation and control)	A	Air flow pattern, air velocity, air pressure, air cleanliness, temperature, humidity, pressure, sealing method, and microbial removal efficiency	Broad survey research is necessary

Table 2. Topics for Future Evaluation

Enzyme/microbe-applied technology:	Lipase, cellulase, glucose oxidase Urease
Artificial mutation-applied technology:	Air filter lug, ultrafilter membrane
Recombinant DNA-applied technology	DNA synthesizer, restrictive enzyme
Cell fusion technology: Cell mass-culture technology:	Cell wall solubilizing enzyme Filtration sterilization device Clean bench
Protein-engineering-related technology	Synthetic nucleic acid
Separation/purification technology for Microquantity biochemical substances:	Separation base material, Column performance, various separation membranes
Biosensor technology:	Sensors for uric acid, urea, and lactic acid
Common items:	Environmental protection equipment (ultraviolet and gas sterilizers)

Purification of Enzymes and Proteins and Establishment of Standardization Specifications, by Norio Okuyama, Professor, Biochemistry Section, Science Faculty, Tokyo Municipal University

1. Introduction

   Domain of biosciences (biotechnology, bioindustries)
   What is science? (Time-space coordinates)
   Elements constituting living body and elements constituting the earth

2. Polymeric substances constituting cells

   Informational polymers
   Control polymers
   Structural and metabolic polymers

3. Systematic analysis of proteins

   3.1 Distribution
   3.2 Extraction method, purification method, and purity
   3.3 Storage method--sterilization method
   Cell bank, DNA bank, protein bank

4. Artificial proteins

- 4.1 Protein engineering
- 4.2 Chemical synthesis of protein
- 4.3 Chemical modification of protein
- 4.4 Artificial cells

5. Fixed enzyme or protein

- 5.1 Fixing materials
- 5.2 Fixing methods
- 5.3 Bioreactor
- 5.4 Affinity chromatography packing material

6. Specification-established proteins and fixed proteins

7. Conclusion

Standardization and Problems of Separation Membranes, by Haruhiko Oya, Material Engineering Section, Engineering Faculty, Yokohama National University

1. Nomenclature Concerning Membrane Separation Methods

First, I will briefly explain the nomenclature and types of membrane separation methods. Appropriate energy is required to separate things. Thus, the nomenclature depends on the type of energy used. When primarily the solvent passes through the membrane, the phenomenon is called the osmotic phenomenon, whereas, when the solute passes, it is called the dialytic phenomenon. For example, the permeation phenomenon, in which the concentration differential, a form of chemical energy, is used as a driving force primarily to pass the solute, is called osmosis. As shown in Table 1.1, the permeation phenomena, in which electric energy is used with electric potential as a driving force, are called electro-osmosis and electrodialysis, respectively. Similarly, the permeation phenomena using dynamic energy are called pressure osmosis and pressure dialysis (reverse osmosis, ultrafiltration, microfiltration).

In Table 1.2 the membrane processes, which are considered commercially important, are summarized.

2. Demand

According to the recent statistics of membrane usage, the total sales is ¥65 billion, of which ¥40 billion is for dialysis membranes, ¥15 billion is for microfilters, ¥3 billion is for ultrafilters, and ¥3 billion is for ion exchange membranes. For the United States the prediction is, as shown in Table 2.1, $1 billion or approximately ¥130 billion for 1986.

Table 1.1 Drive Energy and Dialysis/Osmosis

Driving force	Energy	Dialysis (Dual entry-type)	Intermediate osmosis (Most single entry-type)	
Pressure difference (Centrifugal force)	Dynamic	Pressure dialysis		Pressure osmosis (Reverse osmosis, ultafiltration, microfiltration)
			Gas diffusion	Gas osmosis
Temperature difference	Thermal	Thermal dialysis Dialytic evaporation*	Osmotic evaporation*	Thermal osmosis
Potential difference	Electric	Electrodialysis		Electro-osmosis
Concentration difference	Chemical	Dialysis Gas dialysis		Osmosis
Chemical bond	Chemical	Chemical dialysis**		Chemical osmosis**
	Optical	Optical dialysis**		Optical osmosis**

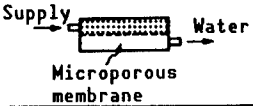
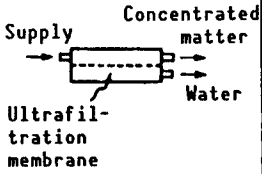
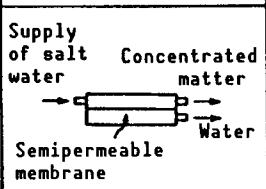
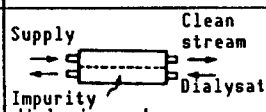
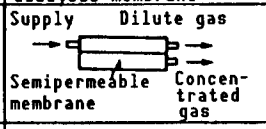
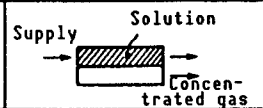
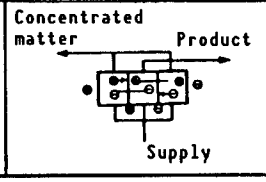
* These are also called pervaporation, or membrane distillation. The trend is to use the general term of permeation evaporation for all of them.
**These are not official names.

3. Need To Standardize Membranes Used in Pure Water Production

The introduction to the "JIS Draft Survey Preparation Report on Membranes for Pure Water Production" in FY86 is as follows.

Recently, in Japan, the leading industries such as semiconductors, pharmaceuticals, and atomic energy, have been using a large amount of purified water, the so-called pure water. Water treated to high purity with filter membranes is called super-pure water. For instance, in the production of semiconductors, the usage of super-pure water is 1.2 tons per 6-inch wafer. On the super-pure water market basis, in FY75 the usage of super-pure water for semiconductors was approximately 30 million tons and it was predicted to increase in FY90 to approximately 130 million tons. In the medical and pharmaceutical industries, it is estimated that nearly 5 million tons of super-pure water processed with ultrafilters and reverse osmotic membranes only, and, with the addition of sterile water processed with microfilters, over 10 million tons of the total membrane-filtered water is being used primarily for cleaning. Also, in the nuclear power plant area, large capacity

Table 1.2 Membrane Separation Processes

Separation method	Concept	Driving force	Passing substances / Residual substances	Application fields
Microfiltration		10~100 kPa Pressure difference	Water and solutes / Suspended particles (silica, bacteria); particle size varies	Production of industrial superpure water; production of clean water; clean filtration of wine, beer, and vinegar; removal of particles, virus, and bacteria from drug solution
Ultrafiltration		50~1000 kPa Pressure difference	Water and salt / Bacteria and colloidal polymers (segregating molecular weight (varies)	Production of industrial superpure water; production of clean water; separation of oil-water mixtures; paint recovery in paint industry; recovery of proteins from waste in dairy and meat processing plants; concentration of liquid and dehydration of egg albumin in dairy industry; concentration and purification of enzymes and hormones; treatment of drug solutions; isolation of blood protein; clean filtration of all kinds; recovery of adhesives in textile industry, effluent treatment in textile, paper, and pulp industries
Reverse osmosis		0.5~6 MPa Pressure difference	Water / All suspended matters and solutes	Desalination of sea water or salt water; dehydration of liquid food products (juice, syrup, and milk); production of instant coffee; concentration of dietetic food products; softening of boiler water; production of industrial deionized water; recovery of useful components in dairy and sugar industries; effluent treatment in paper/pulp industry; waste water treatment in cities
Dialysis		Concentration gradient	Ions and low molecular weight organic matter / Molecular suspended matter with molecular weight greater than 1,000	Artificial kidney and other medical areas; separation of high and low molecular weight matter in chemical, textile, pharmaceutical, and food industries
Gaseous separation		Static pressure difference; concentration gradient	Gas and steam / Gas and vapor, which cannot readily permeate membrane	Industrial oxygen enrichment; industrial nitrogen enrichment; medical oxygen enrichment; separation of methane and carbon dioxide; recovery of helium from natural gas; recovery of rare gases in nuclear industry
Permeation vaporization		Concentration gradient (reduced pressure one side); steam pressure	Substances readily soluble in membrane / Substances not readily soluble in membrane	Separation of co-boiling mixtures such as alcohol-water; production of pure water; recovery of valuable components from industrial effluent; concentration related to food
Electrodialysis		Electric potential difference gradient	Ions / Polymeric materials; anion materials	Concentration of sea water; production of alkalis; desalination of salt water; softening of industrial water; recovery of tartaric acid from wine; treatment of various industrial effluent; recovery of heavy metal ions in plating industry; demineralization in pharmaceutical and sugar industries

filtration plants, such as the condensation system, have been operating since 1985, and the membrane-treated water volume in recycle systems in 1985 was actually over 10 million tons and is estimated to reach 100 million tons in 1990. In this way, all of the pure water production, filter membranes and their devices are playing an important role.

The LSI production process in the semiconductor industry, the largest consumer of water, uses super-pure water, which is made by combining the ion exchange method and the separation by microfilters (MF films), ultrafilters (UF films), and reverse osmotic films (RO films), to remove chemicals and/or microparticles remaining on the surface of wafers in the cleaning process involved in wafer fabrication, mask production, film forming photoengraving processes, and etching processes. If any ions, microparticles, and/or organic substances exist in the super-pure water, they affect the oxides,

multicrystalline film, and wiring in the wafer, and reduce the quality and dependability of LSIs. Along with the higher integration of LSIs, the minimum pattern of a chip, for the 1 M-bit DRAM about to enter into mass production, is said to be 0.5 μm, the size of microparticles allowed to be in super-pure water is said to be approximately one-fifth of the chip's smallest pattern. Thus, increasingly high quality of water is required and the trend is to create increasingly strict demands for the membrane's performance.

On the other hand, in the pharmaceutical industry, Japan Pharmacopeia specifies different types of process water as ordinary water, purified water, sterile water, and distilled water for injection. In the industry, in general, pure water is used as cleaning water in drug manufacturing processes, and in hospitals, as the raw material for injections and eye drops, and for culture water. Recently, due to the improvement of the membrane's capability and its economic advantage, the use of membrane-treated cleaning water has increased. However, in Japan this water has not been approved for use in the preparation of injections which demand the purest water. In the United States reverse osmosis treated water has already been approved for use in the preparation of injections. In this case, the most important specification for use in pharmaceuticals is that materials must be sterile to prevent infection by microbial contamination. In the case of the injection water, it must also be free of pyrogens. Today, in Japan, vigorous examination through health science research is being carried out both by the government and by the private sector to confirm the safety of the membrane processing methods.

In the nuclear power industry, the required water quality is not essentially different from that required by the ordinary thermal power plants. However, to avoid problems of radioactivity accumulation the content standards especially for electric conductivity and heavy metal ions are strict. As for the application of membrane filtration in nuclear power plants, for the boiling water reactor, using the condensation system, emphasis is on the improvement of durability and the greater output of membranes used in artificial dialysis; for example, the filtration device for the radioactive effluent solution (at Kashiwazaki Nuclear Power Plant, Tokyo Electric Power Co., Ltd.) and the condensate filtration device (Fukushima No 2 Nuclear Power Plant, Tokyo Electric Power Co., Ltd.) are already in operation. For the pressurized water reactor, membranes for cleaning the used fuel storage cool water and for cleaning the primary cooling water, are in operation at Takahama Nos 3 and 4 Nuclear Power Plants, Kansai Electric Power Co., Ltd.
as you can see, because of the development of the membrane technology and the progress of pure water manufacturing systems, the usage of pure water in various industries has remarkably increased, and, in turn, the administration is faced with a challenge of new standardization. In July 1985 there was the cabinet proposal to promote the standardization of leading industries such as information, biotechnology, and new materials. In March 1986 the survey for biotechnology standardization system was conducted. (The separation membranes were included in the targets for JIS specifications.) Specifically, in June 1986, the Agency of Industrial Science and Technology, MITI, commissioned the Japan Specifications Association Foundation, as a part of the attempt to establish specifications for pure water, to prepare the new JIS draft for three items for pure water production, including microfilters. In July 1986, additional work was similarly commissioned to cover the new JIS draft

preparation for terminology concerning the pure water production membranes. The objective of the standardization is to try to rationalize production and distribution, and to expand the market by promoting the clearly comprehended JIS specifications through consensus of the producing and using industries as a countermeasure for the lack of standardization in the capability evaluation method and capability indications.

Japan Specifications Association Foundation established the JIS Draft Preparation Committee for Pure Water Production Membranes by appointing experts from industry, government, and academia, and its work has already begun. This is the first attempt to establish JIS specifications in the pure water membrane area. The committee work began first with goal-setting by free discussion and examined the tentative main points of he JIS specifications. At the same time, the survey of foreign specifications, particularly ASTM specifications, and the questionnaire survey of membrane manufacturers regarding structure and dimensions. In the second half the committee work concentrated on the preparation of three basic JIS drafts for microfiltration membranes, ultrafiltration membranes, and reverse osmotic membranes. Standardization for the terminologies was led enthusiastically by the Third Laboratory, AIST, of Tsukuba.

This report is a summary of the initial JIS draft and the rough draft of terminology for pure water production membranes, which, as a leading technology, will have a significant impact on the future progress of industry. We were able to conclude the drafting work in a comparatively short period of time, thanks to the active discussions and energetic efforts by the water-treatment membrane users, in semiconductor, pharmaceutical, and nuclear power industries, membrane manufacturers, and academic people of knowledge and experience. The draft will be the standard for the future JIS establishment for the pure water production membranes, which are the largest market of all the separation membranes, as well as the reference report for the standardization of membranes for other applications such as biotechnologies.

Committee members:

<Government>

MITI: Industrial Water Division (Industrial Location and Environmental Protection Bureau), Chemical Products Division (Basic Industries Bureau), and AIST (Standards Department, National Chemical Laboratory for Industry, Research Institute for Polymers and Textiles, and Industrial Products Research Institute)

<University>

Tokyo University, Yokohama National University, Meiji University, Japan Industrial Water Association, and Water Production Promotion Center

<Users>

Semiconductor: Fujitsu, Ltd., NEC, and Hitachi, Ltd.

Pharmaceutical: Takeda Chemical Industries, Ltd., Sankyo Co., Ltd., and Daiichi Seiyaku Co., Ltd.

Atomic energy: Toshiba Corp. and Mitsubishi Heavy Industries, Ltd.

Water treatment: Japan Organo Co., Ltd., Kurita Water Industries, Ltd., and Nomura Micro Co., Ltd.

<Manufacturer>

MF: Japan Millipore Co., Ltd., Nihon Pall Ltd., Fuji Photo Film Co., Ltd., and Toyo Filter Paper Co., Ltd.

UF: Asahi Chemical Industry Co., Ltd., Daicel Chemical Industries, Ltd., and Nitto Electric Industrial Co., Ltd.

RO: Toray Industries, Inc., Du Pont Japan, Ltd., and Toyobo Co., Ltd.

5. Standardization Items:

1. **Membrane terminology**

2. **Reverse osmotic (RO) membranes**

Structure and dimensions of RO membranes for pure water production
Capability of RO membranes for pure water production
Test method for sodium chloride removal capability of RO membranes
Test method for magnesium sulfate removal capability of RO membranes
Test method for microbe trapping capability of RO membranes
Test method for microparticle trapping capability of RO membranes
Test method for endotoxin trapping capability of RO membranes
Test method for isopropyl alcohol removal capability of RO membranes
Test method for pressure resistivity of RO membranes
Test method for chemical resistivity of RO membranes
Test method for thermal resistivity of RO membranes
Standardization method of separation capability data of RO membranes

3. **Microfiltration (MF) membranes**

Dimensions and structures of MF membranes for pure water production
Capabilities of MF membranes for pure water production
Test method for initial flow of MF membranes
Test method for microbe trapping capability of MF membranes
Test method for microparticle trapping capability of MF membranes
Test method for pressure resistivity of MF membranes
Test method for thermal resistivity of MF membranes
Test method for chemical resistivity of MF membranes

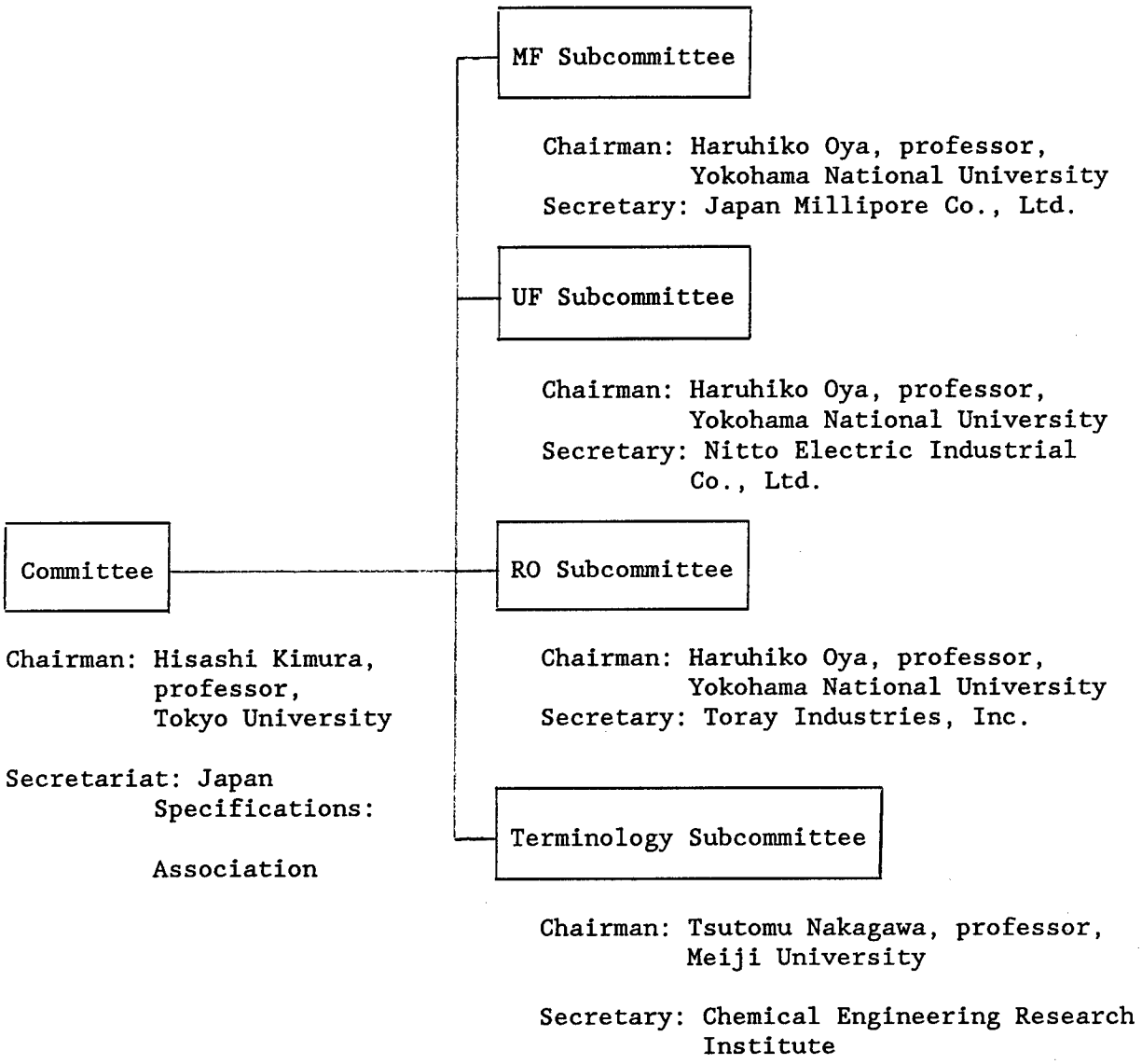
Test method for soluble components (organic matter) of MF membranes
Test method for soluble components (biological safety) of MF membranes
Test method for soluble components (relative resistance recovery capability) of MF membranes
Test method for soluble components (heavy metals) of MF membranes
Test method for soluble components (distillation residues) of MF membranes
Test method for safety check (bubble point) of MF membranes
Test method for safety check (diffusion flux) of MF membranes

4. **Ultrafiltration (UF membranes**

Structure and dimensions of UF membranes for pure water production
Capabilities of UF membranes for pure water production
Measurement method of segregating molecular weight for UF membranes
Test method for filtration capability of UF membranes
Test method for microparticle trapping capability of UF membranes
Test method for endotoxin trapping capability of UF membranes
Test method for solubility of UF membranes
Test method for relative resistance recovery capability of UF membranes

4. Structure of Committee

Table 4.1 JIS Draft Preparation Committee for Pure Water Production Membranes



Committee members:

<Government>

MITI: Industrial Water Division (Industrial Location and Environmental Protection Bureau), Chemical Products Division (Basic Industries Bureau), and AIST (Standards Department, National Chemical Laboratory for Industry, Research Institute for Polymers and Textiles, and Industrial Products Research Institute)

< University>

Tokyo University, Yokohama National University, Meiji University, Japan Industrial Water Association, and Water Production Promotion Center

<Users>

Semiconductor: Fujitsu, Ltd., NEC, and Hitachi, Ltd.

Pharmaceutical: Takeda Chemical Industries, Ltd., Sankyo Co., Ltd., and Daiichi Seiyaku Co., Ltd.

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Test method for relative resistance recovery capability of UF membranes

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13382/9365

IBM Japan, Fujitsu Lock Horns in Battle for Computer Market

Marketing Strategy Reorientation

43067586 Tokyo NIKKAN KOGYO SHIMBUN in Japanese 5 May 88 p 12--FOR OFFICIAL USE ONLY

[Text] In 1982, IBM Japan (President Takehiko Shiina) suddenly introduced a special agent sales system in place of its direct sales system, which previously had been the basic sales policy of the corporation.

Computers have traditionally been sold by direct deals with their manufacturers. IBM Japan in particular had obstinately adhered to the direct sales system for a long period while other manufacturers in Japan were successively adopting the special agent system. IBM Japan, whose principal products are mainframe computers, felt the special agent system would not offer any advantages either for the manufacturer or the users.

At that time, however, the trend in computer demand was rapidly shifting from mainframes to medium/small machines and work stations using distributed processing. From the advent of computers until 1979, IBM Corporation has dominated the Japanese computer market. The reason why IBM Japan lost its top position to Fujitsu that year can be attributed to a come-from-behind victory for Fujitsu in the area of medium/small machines.

The motive force that enabled Fujitsu to garner the honor of becoming the top manufacturer of medium/small machines lay in its agents who were under special contract to it. These special agents--including individuals from such listed firms as Fujitsu Business Systems, Tsuzuki Electrical Industry and Daiko Electronic Communications--have made a major contribution to the sale of Fujitsu computers. For this reason, IBM Japan could no longer stand by without building a special agent network if it wanted to participate in the distributed processing field. In the future, computer sales cannot rely upon out-gunning the competition with a "heavy artillery policy," said Takuma Yamamoto, who took office as the president of Fujitsu in June 1981.

This "heavy artillery policy" refers to a marketing strategy that emphasizes mainframes as basic products. Although Fujitsu had already started to stress the sales of medium/small machines, office computers and personal computers [PCs] by introducing the special agent system, the basic position of the firm was still based on the "heavy artillery policy." The new

computer sales strategy was intended to correct and revitalize this conventional sales strategy.

The criticism of the "heavy artillery policy," as stated by President Yamamoto, a former military officer, was based on the idea that equal efforts should be made to promote sales of medium/small machines, office computers and PCs as well as mainframes. It was a drastic change in computer strategy, and it came from watching the trends at an important period in the development of computer demand.

Takuma Yamamoto and Takehiko Shiina are the presidents of computer manufacturers representing Japan and the United States. One is a former military officer with a firm character, while the other is a shrewd businessman who studied at Keio University and in the United States. Although they are men with different backgrounds, their perception and actions in the period from 1981 to 1982 when the demand for computers was restructured were identical.

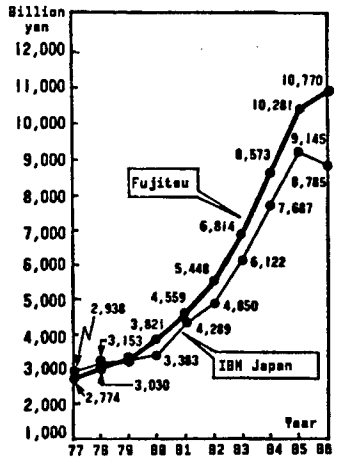
Fujitsu's annual computer sales currently total ¥1.230 trillion (estimate of settlement in March 1988), while the figure for IBM Japan is ¥1.0606 trillion (as of December 1987). The number of special agents for the two firms, which has increased through the introduction of the special agent system and the abandonment of the "heavy artillery policy," is 210 for Fujitsu and 135 for IBM Japan. Fujitsu has 11,000 system engineers, including the staff of affiliated firms, while IBM Japan has no more than 5,000.

Fujitsu's results in regard to both sales network and sales volume are slightly better than those of IBM Japan. However, a simple juxtaposition of figures does not offer a real comparison between them. Between these firms lies the difference in the "business climates" of Japan and the United States, including the breakdown of models sold and maintenance of the profit ratio.

What we can see at present is that both companies' sales of medium/small machines, office computers and PCs associated with distributed processing are increasing. The shares (based on value) of computer sales of the two firms are as follows: IBM Japan's share of mainframe models is about 32 percent, while the corresponding figure for Fujitsu is 22 percent. In the area of medium size models, the figures are about 38 percent for Fujitsu and 11 percent for IBM Japan. It is especially notable that Fujitsu's sales of office computers, which used to be low, are now excellent, rivaling those of NEC Corp.

As to the share (based on the number of units) of PCs introduced by major businesses, about 23 percent are from IBM Japan and 20 percent from Fujitsu (both figures are industry estimates). This means that IBM PCs, which were not noted by industry watchers at all, are now making inroads into Japanese businesses. Both of these facts are examples showing that the development of new strategies has successfully matched the trends of the times. However, it should also be noted that as long as the strategies of the two companies resemble or are identical to each other, there will be an even

fiercer sales competition. The competition between IBM Japan and Fujitsu, which used to be mainframes versus compatibles, has now entered the phase of an all-out struggle in the areas of medium/small machines, office computers and PCs.



Based on figures released to the press. Fujitsu sales to March next year, and IBM sales to December

Figure. Transition of Computer Sales of IBM Japan and Fujitsu

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Copyright Dispute Arbitration

43067586 Tokyo NIKKAN KOGYO SHIMBUN in Japanese 12 May 88 p 32--FOR OFFICIAL USE ONLY

[Text] "This arbitration decision is a victory for all three parties--IBM, Fujitsu and the users of compatible machines." Robert (Manukin), the arbitrator from the Arbitration Affairs Association (AAA), who settled the computer copyright dispute between IBM and Fujitsu, explained the significance of the arbitration in an interview with the Japanese press on 16 September 1987, the day following the arbitration decision. A victory for users--this was the first time such a concept had been raised in the entire history of this dispute. The copyright dispute between the two firms was initiated by IBM, which submitted a claim to arbitration arguing that in October 1985 Fujitsu had copied IBM software without authorization. Since then, it was thought that strong arguments had developed concerning copyright infringement and the range of copyright protection.

However, the AAA "did not try to determine the existence of an infringement," according to Mr Manukin. This was based on the assessment that it would not contribute to the solution of the problem between the two firms to determine whether there was actually a copyright infringement or not.

The substance of the arbitration decision was, first, that IBM will provide software information to Fujitsu, and, second, Fujitsu will pay compensation for the software information received. By respecting IBM copyrights, by assuring the development and maintenance of compatible machines, and, consequently, by protecting the users of compatible machines this arbitration resolved the dispute to the benefit of all three parties.

Immediately after the arbitration decision, President Yamamoto of Fujitsu declared that it would be a "great asset to the developers of compatible machines, releasing them from claims associated with intellectual property." For Fujitsu, which has asserted that "the mission of compatible machine manufacturers is to respond to the requirements of most computer users for equipment compatible with IBM products" (President Yamamoto), the AAA arbitration ruling was an impeccable judgment, not only assuring the policy of compatibility but also taking into consideration the benefit of users as an important factor.

In October 1987, Fujitsu began to reorganize its software development department. The development capacity of its Numazu factory, which is devoted to the OS (basic software) required for compatible machines, is now increasing by 40 percent every year.

In addition, in 1988, Fujitsu decided to import and sell general-purpose mainframe computers that are fully IBM-compatible PCMs (plug compatible machines) from one of its U.S. affiliates. By extending the line of its compatible machines through the introduction of the PCMs, Fujitsu is attempting to acquire users it has not been able to capture with its own machines. Both of these new measures are aimed at enhancing Fujitsu's compatible machine strategy by taking advantage of the settlement of the IBM copyright dispute that lasted for nearly 3 years.

Against such an "offensive" by Fujitsu, IBM has prepared a series of counterattacks, asserting that, "the provision of the necessary information for the development of compatible machines is only permitted within the bounds of the security and facility system controlled by third-party experts and arbitrators. Considering the fact that copying is not permitted, the development of compatible machines after the arbitration has now become more difficult" (IBM Japan).

The first counterattack was the "Fujitsu-IBM Translator" sold in Japan and Australia, where the numbers of Fujitsu users are most important. This software program allows application software developed for Fujitsu computers to be executed on IBM machines. It is one of the trump cards for converting Fujitsu computer users to IBM machines.

The second counterattack was a new OS architecture called ESA/370 (Enterprise System Architecture) released in February 1988. In the short run, this allows the use of software programs for the management of data in external storage devices. It will undoubtedly be the basis of IBM's mainframe machine strategy in the nineties.

IBM's statement to Fujitsu was: "This system is an original and unique invention" (according to Nobuo Mitsui, executive director of IBM Japan). These words are based on the language of the AAA arbitration, which specified that "original and unique software is not subject to the charged information provision."

IBM's share of the international general-purpose computer market, which has a total value of about ¥4 trillion, is about 60 percent, while Fujitsu's share is 10 percent, in second position. While the shares of non-IBM compatible machine manufacturers are decreasing, the markets and users of IBM and IBM-compatible machine manufacturers, including Fujitsu, are steadily increasing.

The IBM-Fujitsu copyright dispute and the AAA arbitration occurred under these circumstances. Regardless of whether ESA/370 is an original and unique invention or not, the struggle between the two "giants" and its outcome can no longer be evaluated without consideration of the users, or the influence it exerts on the users, as indicated in the AAA arbitration.

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Use Survey, Types, Status of Robot Sensing Technologies

Robot Sensor Use Survey

43064047 Tokyo OHTOMESHON in Japanese Apr 88 pp 10-13--FOR OFFICIAL USE ONLY

[Article by Yoshikawa Masanori, Tokyo Institute of Technology: "Problems in Standardizing Industrial Robot Sensors"]

[Text] Visual, tactile, and other sensors must be developed in order to achieve sophisticated and multifunctional industrial robots. Some robot manufacturers have off-the-shelf items that provide these sensors, but in most cases, previously purchased universal sensors are used.

This article reports on the results of the survey we conducted on the actual use of these sensors and on our systematization of these results with a view to establishing standardization guidelines. This article is based on the FY 1986 Report on the Work of Promoting the Standardization of Industrial Robots (Surveys and Research on the Standardization of Industrial Robot Sensors).

Role of Sensors in Robots

Figure 1 shows the result of an analysis of the robot system to clarify the role of sensors. External sensors sense, detect, and recognize information concerning the object, the computer makes a decision based on that information, and the actuator operates. Meanwhile, internal sensors control the position and power of the robot itself.

Thus, the roles of sensors used for robots include:

(1) Information collection, such as sensing, detection, and recognition of an object

(2) Internal supervision and control of the robot

(3) Transfer of information between man and robot

Table 1 shows JIS terminologies concerning robot sensors.

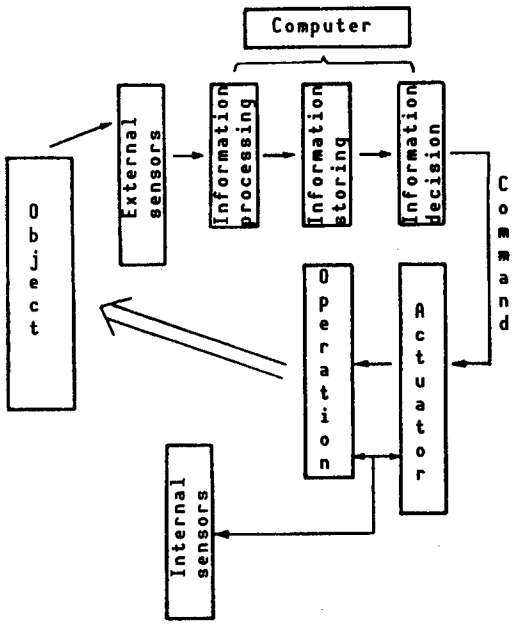

Figure 1. Robot System

Table 1. Definitions Prescribed by Industrial Robot Terminologies (JIS B 0134-1979

Terminology	Meaning	English equivalent (for reference)
Shokkaku	Sense of touch between the robot and the object	tactile sense; sense of touch
Akkaku	Sense of force the robot registers in a vertical direction in regard to surface contact between the robot and the object	sense of contact force
Rikikaku	Sense of force concerning the operation of the robot	inner force sense
Shikaku	Sense of external optical information	visual sense
Chokaku	Sense of external acoustical information	acoustic sense; sense of hearing
Kinsetsukaku	Sense by which to detect that the robot and object have approached within a certain range	sense of proximity
Kankaku seigyo	Control of robot operation by sensory information	sensory control

The robot system, unlike the instrumentation control system of the past, requires the patterning and processing of large quantities of information coming in from the sensor. It differs from other systems in that the objects of observation by the robot are diverse and the method of observation includes software designed to solve problems.

The necessary functions of robot sensors are diverse; they include recognition and identification of shape, symbols, color, relative brightness, and voice, indicated in Table 2. How well these sensors can be used is important for the development and utilization of robots.

Table 2. Senses of Robots

Type of sense	Function and purpose
Visual sense	• Recognition of shape, symbols, color, etc. • Recognition of defective parts • Recognition of position
Acoustic sense	• Recognition of voice • Sensing, detection, and recognition of abnormal sound, etc. • Recognition of position
Tactile sense	• Recognition of shape • Recognition of surface condition • Recognition of hardness, etc. • Detection of temperature of object (noncontact case included)
Olfactory sense	• Sensing, detection, and recognition of ambient gas, etc. • Presence of abnormal gas
Static sense	• Control of balance of robot itself

Factfinding Survey on Sensors

A questionnaire survey for manufacturers and users who are members of the Japan Industrial Robot Manufacturers Association was conducted to ascertain how sensors are used in industrial robots. Separate tabulations were made of the responses of manufacturers (61 companies) and users (23 companies).

For both manufacturers and users, numerical control robots and playback robots account for the majority of robots developed and used in the past, as indicated in Table 3. The number of sensory control robots has gradually increased, and they now represent about one-third of numerical control robots. As for adaptive control robots and learning control robots, few seem to have been produced. The fact that the robots in use by both manufacturers and users exhibit much the same trend shows that the relationship between demand and supply is proceeding in a well-balanced manner.

Table 3. Types of Robot

Robot classification	Manufacturers	Users
(1) Operating robot	2	0
(2) Sequence robot	3	1
(3) Playback robot	29	11
(4) Numerical control robot	30	8
(5) Sensory control robot	10	4
(6) Adaptive control robot	1	0
(7) Learning control robot	0	1

Table 4. Applications of Robots

Application		Manufacturers	Users
A-1	Casting	3	0
A-2	Diecasting	3	0
A-3	Resin molding	3	0
A-4	Heat treatment	1	0
A-5	Forging	2	1
A-6	Pressing	6	1
A-7	Welding	7	1
A-7-1	Arc welding	13	0
A-7-2	Spot welding	3	0
A-7-3	Gas welding	0	0
A-8	Painting	2	0
A-9	Plating	0	0
A-10	Cutting and grinding	5	1
A-10-1	Cutting and grinding (including polishing and deburring)	9	1
A-11	Assembly	15	4
A-11-1	Inserter/mounter	17	4
A-11-2	Bonder	1	3
A-11-3	Sealing	14	2
A-11-4	Other assembly work	22	9
A-12	Handling of incoming and outgoing goods	9	0
A-13	Inspection/measurement	11	3
A-14	Other	6	3
B-1	Offshore development	0	0
B-2	Atomic energy	5	1
B-3	Construction/mining	1	3
B-4	Other	1	0

*Figures do not agree with total because details are not available.

When considering the use of robots, it is necessary to distinguish between applications to manufacturing industries and those to nonmanufacturing industries. Most robots are used in manufacturing industries, and, as indicated in Table 4, they are used mostly for assembly work and the handling of incoming and outgoing goods. The next most important applications are inspection and measurement, casting, diecasting, and resin

molding in the molding industry, and pressing. These robots mainly use visual sensors, indicating the importance of visual sensors.

The answers obtained concerning the types of sensors used for robot systems, the purposes of their use and the present status of their performance, shown in Tables 5-8 (pp 14-20) [not reproduced], are interesting.

The sensors mounted on robots can be divided into internal sensors and external sensors. Of the internal sensors, the position sensor is an encoder or a limit switch, the speed sensor is a tachnogenerator and the attitude sensor is often an inclination sensor. Of the external sensors, the visual sensor is an ITV camera or an Si-CCD, the tactile sensor is a limit switch or a microswitch, the contact force sensor is one that uses conductive rubber, the proximity sense sensor is a proximity switch or a photoelectric switch and the distance sense sensor is an ultrasonic sensor or an optical sensor.

What Must Be Done To Promote Standardization

Table 9 consolidates the responses as to the degree of necessity of standardizing robot sensors, while Table 10 provides typical opinions on standardization not included in Table 9. Quite a few opinions acknowledge the necessity of standardizing interfaces.

Table 9. Necessity of Standardizing Robot Sensors

Item	Manufacturers				Users			
	a	b	c	d	a	b	c	d
1) Types of classification of sensors	9	42	8	1	6	15	1	0
2) Sensor terminologies	17	39	4	0	8	14	0	0
3) Sensor symbols	22	34	4	0	6	16	1	0
4) How to indicate sensor performance	23	35	3	0	12	11	0	0
5) How to test sensor performance	23	34	4	0	8	15	0	0

In the table, a, b, c, and d show: a: urgently necessary; b: necessary sooner or later; c: not necessary; and d: should not be done.

To robot users, the standardization of robot sensors would be convenient for reasons of interchangeability in case of sensor breakdown, and moreover, could result in cost reduction by the effect of mass production. Cost reduction is desirable not only to robot users but to robot manufacturers as well. Standardization also helps technological progress.

In these circumstances, the following standardization of robot sensors is deemed necessary:

Table 10. Opinions on Standardization

Necessary	It is necessary to standardize sensor interfaces (wiring, data formats, etc.)
	It is necessary to standardize data volume in connection with the transmission and reception of data in visual sensor robots
	It is necessary to set standards for detection performance from the standpoint of safety of the robot
	It is necessary to unify the indication of basic terminologies and functions (performance)
	Standardizing wire terminal connectors is desirable from the standpoint of maintenance
	Interchangeability between products by different manufacturers cannot be achieved unless signals from sensors are standardized
Necessity is questionable	Since robot functions are now being improved and the work in which robots are used is expanding, I see no need to standardize sensors
	Standardization may suppress the development of robot technologies that are still immature
	Standardization will dampen the efforts of smaller manufacturers because the larger manufacturers are likely to take the initiative in standardizing

(1) Basic terminologies concerning robot sensors: It is hoped that these will be consolidated and unified systematically. Different manufacturers and users use different terminologies, but basic terminologies, at least, can and must be unified.

(2) It is hoped that the performances of robot sensors will be clearly defined by classification of their functions, and the basic characteristics of each sensor will thereby be standardized.

(3) Standardization of the interface between the output side of the robot sensor and the input side of the signal processor is strongly desired.

However, there are various problems that must be solved in order to push standardization. The standardization of robot sensors might deter technological progress. If, for instance, fitting methods were unified in

standardizing robot visual sensor, it could impede miniaturization by technological advancement.

Caution must be exercised lest the standardization of basic characteristics have the adverse effect of deterring the progress of technological research and development. Besides, standardization might necessitate the modification of robot designs.

Our factfinding survey on robot sensors, in which we collected opinions on their standardization, revealed that the majority of answers supported standardization as necessary. In particular, many stated the necessity of conducting studies to standardize sensor terminologies, basic characteristics and interfaces. Regarding the time of standardization, however, some favored prompt action while others counselled caution as to timing. It is therefore viewed as desirable for robot sensors to be standardized gradually.

This article is based on the Surveys and Research on the Standardization of Industrial Robot Sensors which was conducted by the Special Committee for Research on the Standardization of Industrial Robot Sensors (chairman: the author) created by the Japan Industrial Robot Manufacturers Association and composed of men of learning and experience and robot manufacturers and users.

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Visual Sensing

43064047 Tokyo OHTOMESHON in Japanese Apr 88 pp 21-29--FOR OFFICIAL USE ONLY

[Article by Hidehiko Takano, Government Mechanical Engineering Laboratory: "Visual Technology in Factory Automation"]

[Text] **Present Status of Image Application Technology**

So-called image application technology, comprised of pattern recognition, remote sensing, medical image processing and scene analysis, will be used for many purposes. Its presently conceived uses as a sensing technology include not only defect detection, detection of surface flaws, screening and parts recognition, but also measurement of cutting tool abrasion and measurement of internal defects in materials.

Let us consider technologies supporting image processing from the standpoint of hardware and software. From the aspect of hardware, conditions have been greatly improved due to the recent development of IC technology that has facilitated the securing of large quantities of image memory, which was formerly restrained by cost, and to the progress of image information parallel processing technology as a result of the pipeline formula. But from the standpoint of software, progress is rather slow. Furthermore, the need has presently outstripped the technology, although image processing has many potential applications.

Image Processing Procedure

Image processing follows the procedure illustrated in Figure 1. It can be divided into four parts: image making, image processing, pattern recognition, and knowledge base. a) Image making is the step up to the securing of image information from the object. b) Image processing comprises preliminary processing such as noise elimination and image enhancement, and processing such as characteristic extraction. c) Pattern recognition comprises characteristic description, measurement and pattern matching. And d) knowledge base is the step to make effective use of knowledge, such as the rule of thumb, learning, and inference.

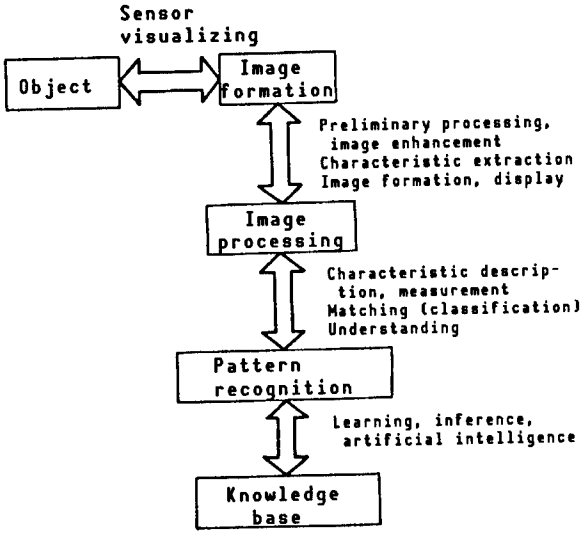

Figure 1. Image Processing

Of these processes, everything from preliminary processing to pattern matching has partially become hardware, but the processes depend largely on software. Also, the introduction of a knowledge base is an important task yet to be accomplished.

Recent Research Trends Ascertained From Papers

Using INSPEC as a database for document retrieval, we conducted a survey on five areas: 1) image processing as a whole, 2) inspection, 3) recognition, 4) assembly, and 5) conveyance. In providing document retrieval, how to set key words is most important. Figure 2 shows the number of documents retrieved each fiscal year for image processing as a whole. It indicates that the number of documents increased each year.

Figure 4 is a graph showing for each fiscal year the change in the proportion represented by "documents concerning real-time image processing aimed at automation (shown with a solid line)," "documents concerning real-time image processing using artificial intelligence (broken line)" and "documents concerning real-time image processing using artificial intelligence and aimed at automation (dotted line)" among the "documents concerning image processing" obtained by document retrieval. From this, it

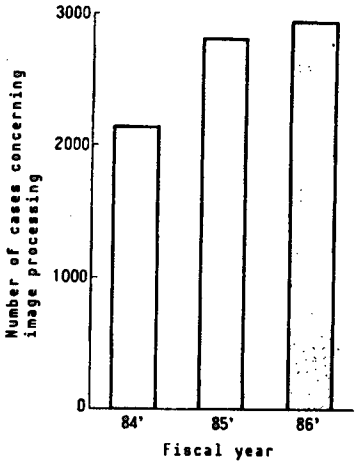

Figure 2. Number of Cases by Fiscal Year

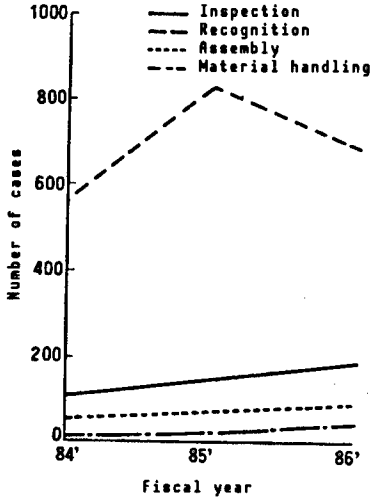

Figure 3. Number of Usage by Application Field

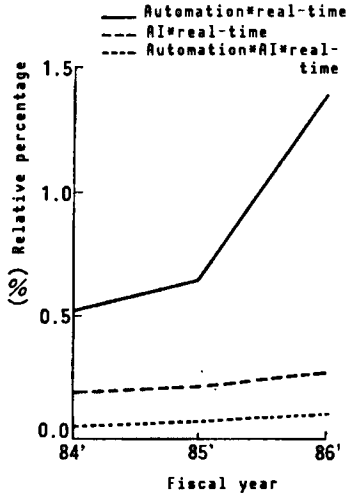

Figure 4. Relative Percentage: Automation/AI/Real-time

can be seen that documents concerning real-time processing were few, and that the proportion represented by those concerning "automation" among the documents concerning image processing was only 0.52~0.27 percent. And the proportion of those concerning "artificial intelligence and automation" was extremely small, 0.05~0.1 percent, namely, one out of every 1,000~2,000. This means that the present level of image processing technology is too low to be applicable to real-time processing and automation. In particular, the instances in which artificial intelligence is applied to automation are practically nonexistent. This trend is true for all 3 years concerned. However, research on applying image technology to automation has been accelerated during the past several years.

Figure 3 shows the number of documents retrieved in the areas of inspection, recognition, assembly, and conveyance. This result indicates that in image technology, the order of advancement in research is: recognition-inspection-assembly-conveyance. This is generally as expected.

Image Processing Technology for Factory Automation

The applications of image processing technology to automation line include product defect inspection, sorting/classification, preassembly and assembly work. For application to these types of work, it is absolutely necessary that processing be simple and brief and that the cost of equipment be low.

Table 1. Image Application Technologies

Work	Measurement information	Measuring systems
Defect inspection	Fixed shape	• Template matching • Expansion and contraction • Projection value
Sorting and classification	Variable shape and size	• Window • Area, circumference, circumference:area ratio • Shape eigenvalue
	Variable shape, size and attitude	• Projection characteristic • Geometric moment • Differentiation
Preassembly	Fixed shape, position, and attitude	• Partial matching
Assembly	Size, position, and attitude	• Standard mark setting
	Variable, shape, position, size, and attitude	• Slit pattern • Laser spot • Corner tracing

Table 1 shows the typical image application technologies for factory automation. We shall look at instances in which image processing technology is applied to automatic machines.

1. Application to Defect Inspection

Many efforts are being made to automate visual inspection, which has hitherto been conducted by workers. Particularly in inspecting printed boards, ICs, and masks, patterns are becoming increasingly detailed and the requirements of inspection are now strict for such reasons as the yield and reliability of products. Therefore, to speed up inspection, there is strong demand for automating visual inspection.

(1) Template matching formula

This formula is a means to detect defects by putting together the image received from the ITV camera and a standard template image without making any characteristic extraction from the former. It is simple processing, performed by comparing the contents of the buffer memory in which the standard template is housed and the image data obtained from the object of inspection, picture element by picture element. Therefore, it can easily be made into hardware and the processing is speedy. But the images to be compared must be precisely aligned, and comparison cannot be accomplished if the position or attitude of the object changes. Figure 5 is an example of application of this method. Here, it is designed so as to contract or expand the standard template image and absorb it in order to eliminate the effect of slight dislocation or image instability in the contour.

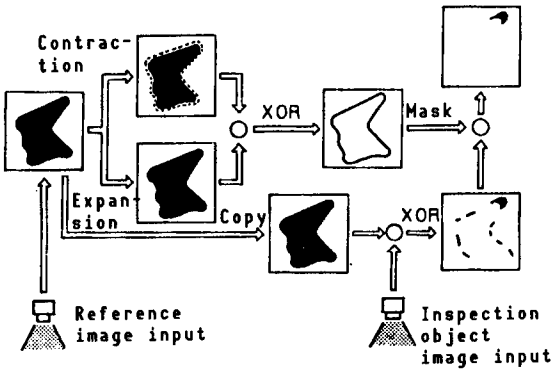

Figure 5. Template Matching Systems

(2) Expansion/contraction formula

The above formula uses a standard pattern as the basis, but a method not using such a standard has been proposed. It takes advantage of the fact that if the picture element in a pattern on a printed board is expanded to a circle with a certain radius and then contracted, the characteristics of the original pattern remain unchanged. This is called expansion/contraction formula. Figure 6 shows its principle. The black very small defect disappears by the propagation (contraction) of the white picture element and the white very small defect disappears by the propagation (expansion) of the black picture element. Therefore, only defects are detected by inverse computation and comparison with the original pattern.

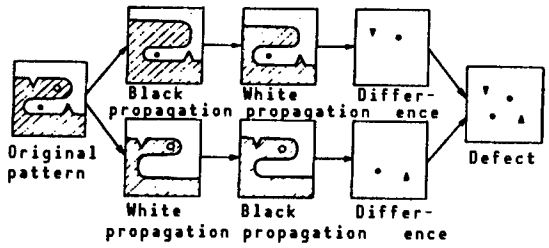

Figure 6. Expansion/Contraction Formula

(3) Projection value formula

Figure 7 shows the principle of a method to check the external shape of a square semiconductor chip and the defective marks on its surface. These are detected by deviations in width, height, etc., from the standard state of the projected pattern obtained by projecting a binary chip pattern in two directions: longitudinal and lateral. The inspection is aimed at detecting the presence and extent of cracks, chips, protrusions, and defective marks on the surface.

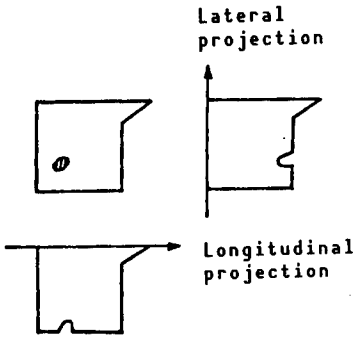

Figure 7. Projection Value Formula

2. Application to Sorting and Classification

In the work of product sorting and classification, usually the position of the object is more or less certain and its shape is known.

(1) Formula using window

Sorting is sometimes performed by setting a line mask or a window mask on characteristic parts, rather than using image data on the object as a whole, measuring feature quantities such as length and area in these marked parts, and comparing them with the feature values in normal products. Thus, the amount of image data to be processed is reduced and high-speed processing is realized, taking advantage of lines and windows. Also, accommodation to accessories of different shapes can be achieved by changing the line arrangement or window shape.

Figure 8 is an example of application to inspection of the external shape of screws. The screening of nondefective and defective products is performed by measuring the head diameter, underhead lengths, and thread pitches of screws. Here, the underhead lengths and head diameters of screws are measured by windows W_1 and W_2. Figure 9 is an example showing application to a label on a bottle and liquid level checking. In checking the liquid level, two windows, W_1 and W_2, are used to detect the inclination of the label and another window, W_3, is used to detect the lateral deviation of the label.

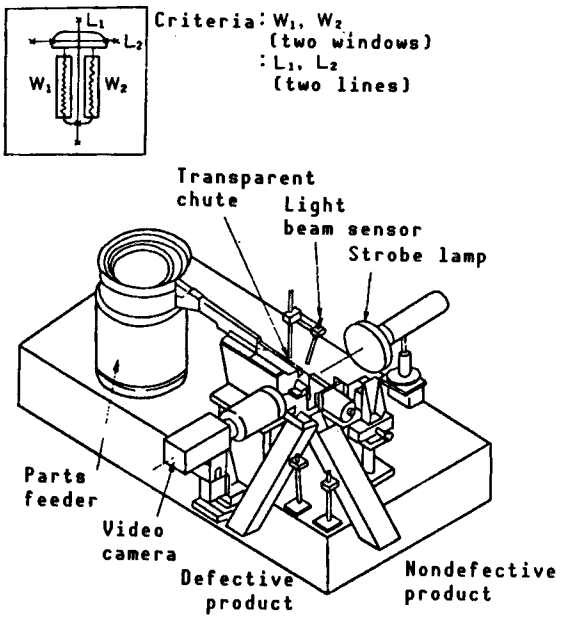

Figure 8. Inspection of External Shape of Screw

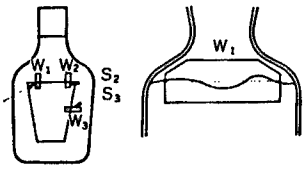

Figure 9. Inspection of Bottle

(2) Formula using feature values such as area, circumference, and circumference:area ratio

Grade decision is made for a spherical fruit such as an orange. Figure 10 shows the shape parameters measured from picture elements by an ITV camera. The decision on the grade of the fruit is made on the basis of average radius, area, circumference, and the degree of deformation. In Figure 11, inspection of the appearance of pharmaceutical capsules is performed in accordance with the principle indicated. Feature parameters for four items --area, axis length, straight line length of joint, and domed shape at both ends---are used to measure the outside of the capsule. The inspection consists of checking for the adhesion of foreign matter to the surface, holes, cracks, dents, and hairline splitting.

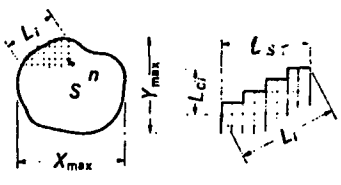

Figure 10. Inspection of Fruit

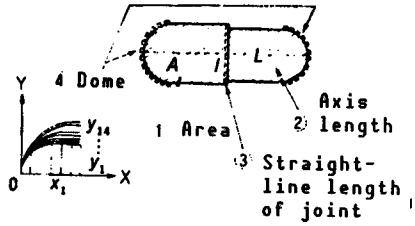

Figure 11. Inspection of Capsule

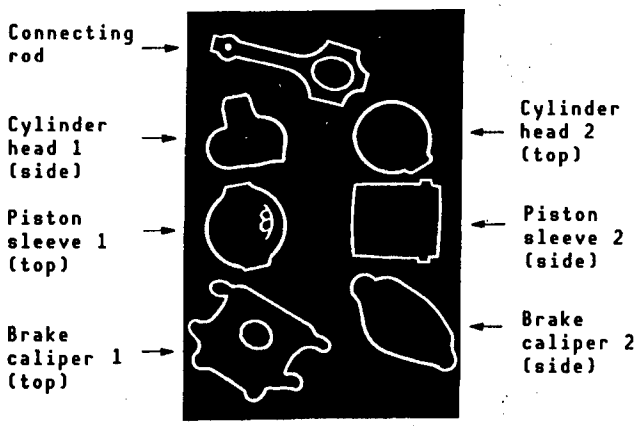

Figure 12. Screening of Automobile Parts

Automobile parts, such as those shown in Figure 12, appear as images through the use of an ITV camera installed right above the conveyor belt. Then, parts are classified on the basis of a logical judgment on seven types of geometric features: circumference, the value of the square root of the area, the total area of holes, the minimum distance from the center of gravity to the external contour, the maximum distance from the center of gravity to the external contour, and the circumference: area ratio.

(3) Shape eigenvalue formula

The characteristic parameter called shape eigenvalue is the value obtained by the projection of a graphic, as shown in Figure 13, to be used as a dimensionless area ratio. The shape eigenvalue is defined as $S=A_a/(A_X \cdot A_Y)$ from distances P_1 and P_2 and area A_a in Figure 13(b). Regardless of the attitude angle, θ, this value is constant in regular polygons except square shape with a multiple of four, and it is possible to classify shapes from this value.

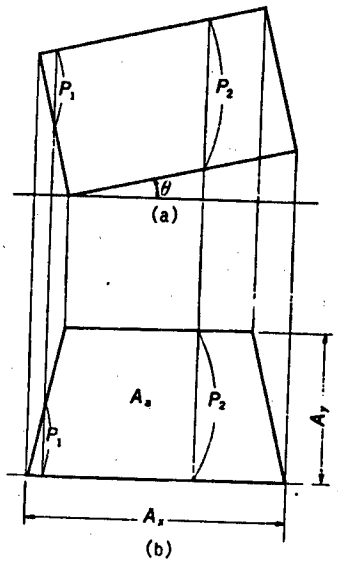

Figure 13. Shape Eigenvalue

(4) Projection characteristic formula

There is also a method using the projection value of a graphic. Figure 14 shows the characteristic curve presented when H, projection value of a graphic, is measured by eye-movement trace. This variable is characteristic for shape, and shape identification is made from the maximum and minimum numbers of projection values or from their characteristic values.

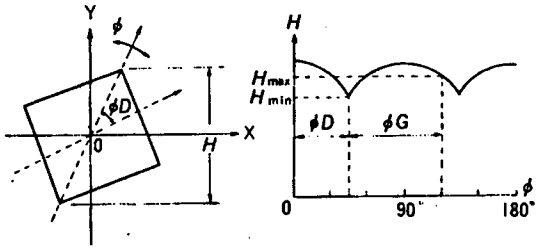

Figure 14. Projection Characteristic Formula

(5) Geometric moment formula

The center of gravity and the principal axis of inertia obtained from a plane shape are important as feature quantities showing the position and attitude of the object. The center of gravity shows the position of the object, while the principal axis of inertia shows its direction. Furthermore, the equivalent ellipse of inertia is defined for the axis of any shape passing through the center of gravity, and its length and breadth are often used as feature quantities. The drawbacks of this method can be improved by combining it with the aforementioned template matching formula, and it can be used for objects with changing positions and attitudes. Figure 15 [not reproduced] provides an example of the results of what was done to find a moment of inertia and measure the position and attitude angle of where the key lay.

(6) Differentiation formula

As shown in Figure 16, graphic pattern P is converted into a projection for the two orthogonal axes, X and Y, and the projection is differentiated. The differential waveform obtained thus has positive and negative pulse arrangements that differ according to various shape patterns. Geometric graphic patterns can be identified by taking note of this fact.

(7) Centerline retrieval formula

A graphic is expressed by the combination of simple basic graphics (primitives), such as a rectangle and a trapezoid, and this is taught in the form of dialogue. The stored data includes the size and shape of primitives, the distance between centers of gravity, and the direction cosine of the straight line between centers of gravity. By this method, the centerline in the closed graphic domain is extracted and used as a line element group, and something with a length agreeing with the length of the

there is a regular air route in the sky about 10 kilometers to the west; however, they are sufficiently separated from the facility, and aircraft are restricted from flying over atomic energy facilities. Therefore, Council says that the possibility of an airplane crashing into the facility is extremely slight.

Moreover, concerning also the effect if an aircraft were to crash into the facility, the Council set forth analysis results which held that "the volume of uranium released (at the time of the crash) would be approximately 0.3 curie, and the volume of the public's exposure at the place of maximum exposure outside the facility boundaries would be about 0.6 rem; therefore, it would have little effect."

In addition, the report also certified the safety of the facilities themselves in regard to such site conditions as foundation, weather and waterways, earthquake resistant qualities, fire and explosion prevention, etc.

In regard to critical control in particular, the report says that as a result of considering design conditions and of having calculated criticality with conditions with a sufficient margin of safety, it will not reach criticality in any case whatsoever.

12373/9365

Plan for 600,000 kw of Atomic Power Reported

43062107b Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 21 Jul 88 p 1

[Text] **Electric Coordination Council's 600,000 kw Atomic Power Plan: Current Fiscal Year's Starts on New Electric Power Sources**

At the 109th session of the Electric Power Development Coordination Council, which was held on 20 July, the government decided on the FY 1988 Basic Plan for Development of Electric Power Sources.

According to the plan, it is estimated that in the future electric power demand (August maximum electric power) will grow at an annual rate of about 2.8 percent, and in 1997 will become approximately 151.5 million kw. The plan holds that, confronted by this kind of demand, it is necessary to newly put into operation electric power sources of about 49.57 million kw over the next 10 years in order to strive for stability of electric power supply and demand.

Of this 49.57 million kw, continuation spots (spots which have already passed the Electric Coordination Council) have approximately 39.62 million kw; therefore, work is expected to begin newly on the approximately 9.95 million kw that remain.

Under the plan, based on this kind of background, a target is set forth of beginning work in the current fiscal year on electric power sources totalling 2.75 million kw: 140,000 kw of hydropower, 2.1 million kw of thermal power, and 600,000 kw of atomic power.

Furthermore, it is expected that if the plan proceeds smoothly, at the end of FY 1997 there will be a total of 203.4 million kw of power-generating plant and equipment: 41.34 million kw of hydropower, 115.42 million kw of thermal power, and 46.63 million kw of atomic power.

12373/9365

Tokai To Begin Processing Setup for 90 Tons Per Year

43062107c Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 21 Jul 88 p 1

[Text] **Power Reactor and Nuclear Fuel Development Corporation's Tokai Processing Plant To Begin Processing Setup for 90 Tons per Year; To Begin Work on Improving Acid Recovery Evaporator, Etc.**

In undertaking to improve and strengthen the equipment of the Tokai reprocessing facility, the Power Reactor and Nuclear Fuel Development Corporation [PNC] has placed an order with Kobe Steel, Ltd., for hard fabrication to improve the evaporator of the acid recovery evaporation line and the plutonium evaporator.

Furthermore, in regard also to strengthening the equipment on the clarification line, PNC plans to place orders with (Niki, Ltd.) for manufacture and installation of pulse columns.

The PNC has been proceeding with preparations for this series of improvement construction since the beginning of this year; its aim is to improve system efficiency and preventive maintenance.

The content of the main work this time is such things as: 1) strengthening of the pulse column equipment; 2) complete replacement of the acid recovery evaporator; 3) replacement of the upper part of the plutonium evaporator; and 4) alteration of the structure of the lower part of the acid recovery fractionating tower.

Of these, the acid recovery evaporator is a device for recovering and reusing the concentrated nitric acid which remains after spent fuel has been dissolved. The plutonium evaporator is a device which refines plutonium which is extracted from a dissolved solution. With the niobium-added high-chromium-nickel steel (austenite-group stainless) material which has been used up to now, the progress of nitric-acid caused corrosion is rapid; therefore, the aim is to replace it with a titanium 5 tantalum alloy and to strive to increase system efficiency by such things as lowering the frequency of part replacement.

On the other hand, the clarification device is a device which segregates the spent fuel by means of liquid nitric acid into a solution of uranium and plutonium and a solution of fission product, filters the solution of uranium

and plutonium, and removes the insoluble residue (dirt). When that device filters approximately 20 tons of spent fuel, the phenomenon of blinding occurs in the filter; therefore, it becomes necessary to replace it.

Hitherto, a single train of the clarification device was installed, and replacement required 3 or 4 days; therefore, it was necessary to halt the entire processing line to work on it. This time they will try to enhance operating efficiency by changing it to a double chain.

In addition, all the work is scheduled to be finished by about April 1989, including the improvement work on structural alteration of the fractionating tower.

An increase in efficiency for the entire system of the processing plant is being attempted by means of this series of improvements on equipment; therefore, an increase from a 70-ton annual setup to a 90-ton annual setup is anticipated.

12373/9365

Small Crack in System for Removal of Remaining Heat

43062107d Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 21 Jul 88 p 2

[Text] **Small Crack in System for Removal of Remaining Heat: Genkai No 1 To Implement Measures To Prevent Recurrence**

The results of an investigation into the reason why Kyushu Electric Power Co., Ltd.'s Genkai No 1 nuclear power plant (PWR [pressurized water reactor], output of 559,000 kw) was shut down manually on 6 June were made public by MITI on 14 July.

At the Genkai No 1, beginning at about 0900 hours on 6 June, while the plant was operating at rated output, an increase in influent to a floor drain sump located in the reactor container was seen, so the reactor was shut down by hand at 1728 hours on the same day in order to investigate the cause. As a result of subsequent inspection, it was confirmed that there was damage to the pipe weld zone in the vicinity of the remaining heat-removal system's inlet isolation valve.

According to the results of the investigation this time, a through-crack, 85 millimeters long on the inside and 1.5 millimeters long on the outside, had developed in said pipe, and from the characteristics of the fracture, it was ascertained that the crack had developed because of high-cycle fatigue. Moreover, when a further investigation was made of the reason for the occurrence of high-cycle fatigue, it was ascertained that high-temperature primary coolant had flowed into the pipe of the remaining heat-removal system, the phenomenon of thermal stratification (a phenomenon by which a high-temperature fluid forms a strata above a low-temperature fluid) had occurred, and comparatively high fluctuating stress was repeated due to the fluctuation in that thermoformed strata, that a crack was produced due to high-cycle fatigue, and it developed and became a through-crack.

Therefore, Kyushu Electric Power will make it a practice to put into effect a complete replacement of pipes which have damaged places, including pipes which have analogous conditions.

Furthermore, as a measure to prevent a recurrence, it decided to replace the packing for the shaft-seal part of the inlet isolation valve that was

producing the leak and to adjust the valve at the same time. Moreover, to make doubly sure, it installed a thermometer in the replacement pipe, making it something for which the occurrence and fluctuation of thermoformed strata can be detected.

12373/9365

Atomic Power Cost To Be Lowered by Means of ALWR

43062107e Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 21 Jul 88 p 8

[Text] **Long-Term Forecast of Atomic Power Generating Costs From Report of Energy and Economy Institute: Superiority of Atomic Power Increases; Cost Lowered by Means of ALWR**

As previously reported in our last issue, the Japan Research Institute of Energy and Economy recently put together a survey report on estimates of the economy of atomic power generation and reported it to the Atomic Energy Commission. According to it the report forecast that "in the future, because of the introduction of ALWR, the cost of atomic power generation will decline from the ¥9.36 per kwh of 1987 to ¥7.34 per kwh in the year 2000; so, the superiority of atomic power will increase." In the following we will present a summary of the report.

<Prior Premises for Trial-Calculation of Power-Generation Costs>

Construction Costs

(1) Plants That Commenced Commercial Operation in FY 1987

In regard to model constructing costs for atomic power plants and thermal power plants, we extracted from electric-power facility plans the actual cost and planned cost for 3 years before and after FY 1987. We sought the unit construction-cost for FY 1987 by executing a price correction and a plant-type correction for each plant and established an average price for each mode of power generation.

However, to the construction cost for LNG [liquefied natural gas] thermal power plants, we added ¥60,000 per kw as the construction cost for an LNG reception base and made that the construction cost.

(2) Plants To Commence Commercial Operation in FY 1995 and FY 2000

In regard to the cost of construction for petroleum thermal power and LNG thermal power in FY 1995 and later, we assumed real leveling off of FY 1987 construction costs. As for atomic-power construction costs, for FY 1995 we made it a real leveling off of FY 1987, but we took it that a 15 percent decrease in FY 1987 construction cost can be calculated in FY 2000 because

of the introduction of advanced light-water reactors (ALWR). Furthermore, in regard to coal thermal power, it will be a real leveling off until FY 1995, but we took it that a 10-percent decrease in comparison with FY 1987 construction costs is calculated in FY 2000 because of improvement in environmental-countermeasure equipment.

Fluctuations in Fuel Cost

We estimated fuel cost in the year 2000 to be $51.90 per ton for coal (average CIF [cost, insurance and freight] cost), $32.80 per barrel for petroleum and ¥42,088 per ton (CIF) for LNG.

<Power-Generation Cost by Fiscal Year>

The generation cost for atomic power generation in all fiscal years in which commercial operation commences is less than that for other power sources.

Table 1. Generation Cost for FY 1987 Commencement of Commercial Operation (sending end, equipment utilization rate is 75 percent) (equalized cost)

	Generation cost yen /kWh)				Component ratio (%)			
	Atomic power	Coal thermal power	Petroleum thermal power	LNG thermal power	Atomic power	Coal thermal power	Petroleum thermal power	LNG thermal power
Capital cost	5.59	4.82	2.99	3.90	59.7	46.4	27.7	36.6
Operation cost	2.02	2.03	1.03	1.24	21.6	19.5	9.5	11.6
Fuel cost	1.76	3.54	6.78	5.50	18.8	34.1	62.8	51.6
Total	9.36	10.39	10.80	10.65	100.0	100.0	100.0	100.0

Table 2. Generation Cost for FY 1995 Commencement of Commercial Operation (sending end, equipment utilization rate is 80 percent) (equalized cost)

	Generation cost yen /kWh)				Component ratio (%)			
	Atomic power	Coal thermal power	Petroleum thermal power	LNG thermal power	Atomic power	Coal thermal power	Petroleum thermal power	LNG thermal power
Capital cost	5.24	4.52	2.80	3.66	59.3	43.6	21.2	28.3
Operation cost	1.89	1.91	0.96	1.16	21.4	18.4	7.3	9.0
Fuel cost	1.70	3.94	9.43	8.09	19.3	38.0	71.4	62.6
Total	8.83	10.37	13.20	12.92	100.0	100.0	100.0	100.0

Table 3. Generation Cost for FY 2000 Commencement of Commercial Operation (sending end, equipment utilization rate is 80 percent) (equalized cost)

	Generation cost yen /kWh)				Component ratio (%)			
	Atomic power	Coal thermal power	Petroleum thermal power	LNG thermal power	Atomic power	Coal thermal power	Petroleum thermal power	LNG thermal power
Capital cost	4.45	4.07	2.80	3.66	60.6	40.7	18.1	24.0
Operation cost	1.61	1.72	0.96	1.16	21.9	17.2	6.2	7.6
Fuel cost	1.29	4.19	11.69	10.40	17.6	41.9	75.7	68.3
Total	7.34	9.99	15.45	15.22	100.0	100.0	100.0	100.0

When we look at the portion that commenced commercial operation in FY 1987, because of the recent fall in the price of fossil fuel, even petroleum thermal power, which is the most expensive, is ¥10.8 per kwh, a difference of ¥1.44 per kwh compared to atomic power's ¥9.36 per kwh. In the future, coal thermal power, which appears to us to be able to compete with atomic power, will be ¥10.39 per KWH, the next cheapest after atomic power.

When we look at the portion that commences commercial operation in FY 1995, the generating cost for atomic power becomes ¥8.83 per kwh. Even second place coal thermal power becomes ¥10.37 per kwh, which comes to have a difference of ¥1.54 per kwh; and in petroleum thermal power and LNG thermal power, the difference will have expanded by all of ¥4 or more.

When we look at the portion that commences commercial operation in FY 2000, such things as a decline in construction costs are calculated in atomic power because of the introduction of improved light water reactors; therefore, its economic superiority over other power sources becomes overwhelming. Since its construction cost will drop by 10 percent, second place coal thermal power will also have become a bit cheaper, dropping below ¥10 per kwh at ¥9.99. Compared to these two power sources, petroleum thermal power and LNG thermal power will be affected by a rise in crude oil prices and will have exceeded ¥10 per kwh by fuel cost alone; therefore, their economy will have gotten still worse.

Influence of Rate of Equipment Utilization

We carried out an assessment of economy based on the standard rate of equipment utilization in each fiscal year in which commercial operation commenced; the share of generation costs occupied by capital cost was high for atomic power generation. Therefore, we shall now make clear the manner in which fluctuation in the rate of equipment utilization influences cost.

In the portion that commenced commercial operation in FY 1987, all four power sources have drawn close across the wide range of rates of equipment utilization. But beginning about the time when atomic power surpassed a 50-percent rate of equipment utilization, it reached the point of clearly possessing economic superiority over other power sources.

In the portion that will commence commercial operation in FY 1995, it reaches the point where it is bipolarized into atomic power and coal thermal power on the one hand and petroleum thermal power and LNG thermal power on the other, and the economic superiority of the former will be firmly established when it surpasses the latter by about 40 percent.

Furthermore, when it comes to the portion that will commence commercial operation in FY 2000, the economic superiority of atomic power and coal thermal power will have become overwhelming over almost the entire range of the rate of equipment utilization.

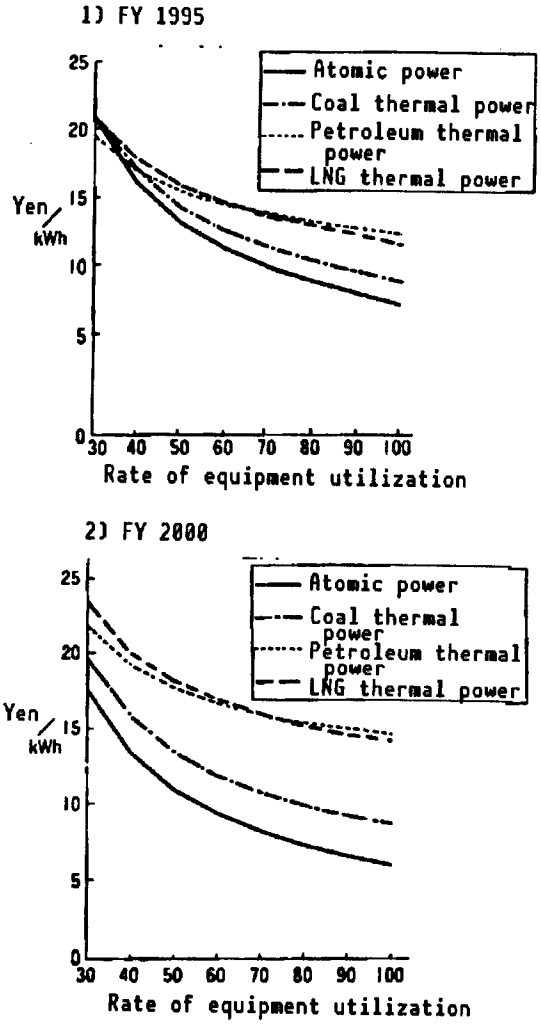

Figure 1. Generation Cost by Rate of Equipment Utilization (equalized cost)

Influence Exerted on Generation Cost by a Decline in Construction Cost

In the atomic power and coal thermal power of the portion that will commence commercial operation in FY 2000, it is thought that construction cost will decline for both because of technological progress. Therefore, in the portion that will commence commercial operation in FY 2000, we will also investigate the level of influence which decrease in construction cost will exert on generation costs for these two power sources in which the importance of construction cost is great.

We decided to consider a 0 to 20 percent margin of decrease for construction cost in both atomic power and coal thermal power.

As a result of trial calculation, atomic power became ¥0.072 per kwh compared with ¥0.065 per kwh for coal thermal generation; therefore, it can be said that generation cost will decline more for atomic power than for coal because of greater efforts to decrease construction cost for atomic power than for coal thermal power.

12373/9365

Overview of International R&D Cooperation for FY 1988

43063036 Tokyo JITA NEWS in Japanese No 6, 1988 pp 4-8

[Text] **Overview of FY 1988 International R&D Cooperation**

International Research and Development Division, Agency of Industrial Science and Technology [AIST]

1. Overview of International R&D Cooperation

International cooperation in the R&D area contributes to the revitalization of harmonious external economic relations along with the efficient implementation of Japan's R&D.

In particular, the importance and need for international R&D cooperation are rising constantly in the advanced industrial science and technology fields because of the hopes for a worldwide economic revitalization caused by the technologies revolution of recent years, the increase in demands and expectations for Japan's contribution to R&D in the advanced industrial science and technology field, and the demands to avoid trade friction.

From such a perspective, Japan is proceeding, more than before, with participating in and sponsoring international conferences, implementing joint research, and participating in joint ventures implemented by international organizations, especially in the area of energy-related technology development. At resent, we are promoting participation in the International Energy Agency's (IEA) summit project as a form of multilateral cooperation, and as far as bilateral cooperation is concerned, we are promoting R&D under the framework of the Japan-U.S. Energy Research and Development Cooperation Agreement and the Japan-Australia Research and Development Council in addition to the science and technology cooperation agreements that we have with France and West Germany. We aim to develop a positive future based on the results of these cooperative efforts.

With regard to solar power and advanced robotics, which were among the 18 cooperative projects agreed to at Williamsburg, AIST has taken the lead to work fully with the other participating countries and to advance these projects aggressively.

In particular, to advance R&D on major international research problems by sharing the burden with other advanced industrial nations, we founded the Specific International Joint Research Project in 1985 and are making a dramatic effort to advance international cooperation through this.

On the other hand, from the perspective of contributing to the progress of worldwide science and technology and economic development, as well as working to improve the technological level of Japan, by positively advancing international R&D in the key technology fields, we have founded the Japan Trust for International Research Cooperation, which uses volunteer funds from the private sector and carries out undertakings with guest researchers from foreign countries.

Furthermore, with regard to the developing countries, we have been carrying out joint research, sponsoring international symposia, and exchanging researchers for the purpose of promoting R&D cooperation in the mining and manufacturing technology field, where there are intense demands from the developing countries, in the form of the Institute for Transfer of Industrial Technology (ITIT). Moreover, along with promoting R&D cooperation projects as research cooperation in the near commercialization stage, the need is high for us to implement research in the developing countries. We are also making every effort to advance comprehensive research cooperation projects by founding local pilot plants in developing countries that cannot complete them themselves, and to expand consigned projects to promote research cooperation which will carry out jointly operated research.

2. Promotion of Research Cooperation With the Advanced Countries

From the viewpoint of working towards the development of our national economy and the fulfillment of our national life, along with contributing to the expansion of the world's economic frontiers, we are positively promoting research cooperation among the advanced countries. Taking into account the agreement reached at the Venice Summit on the Human Frontier Science Program, which we have been advocating to the world, for FY88 we are expanding and intensifying international research cooperation, such as sending out invitations to foreign researchers, young researchers especially, to stay here for a long time, and we are planning a positive promotion.

(1) Specific International Joint Research Project

1) Project objective

The aim of the Specific International Joint Research Project is to carry out joint research of appropriate projects from among internationally important research projects by allocating them internationally among the laboratories under the AIST umbrella and overseas research organizations to advance R&D, and, in this way, to work for efficient and effective advancement of experimental research, as well as to make Japan's international contributions posture appealing to foreign countries.

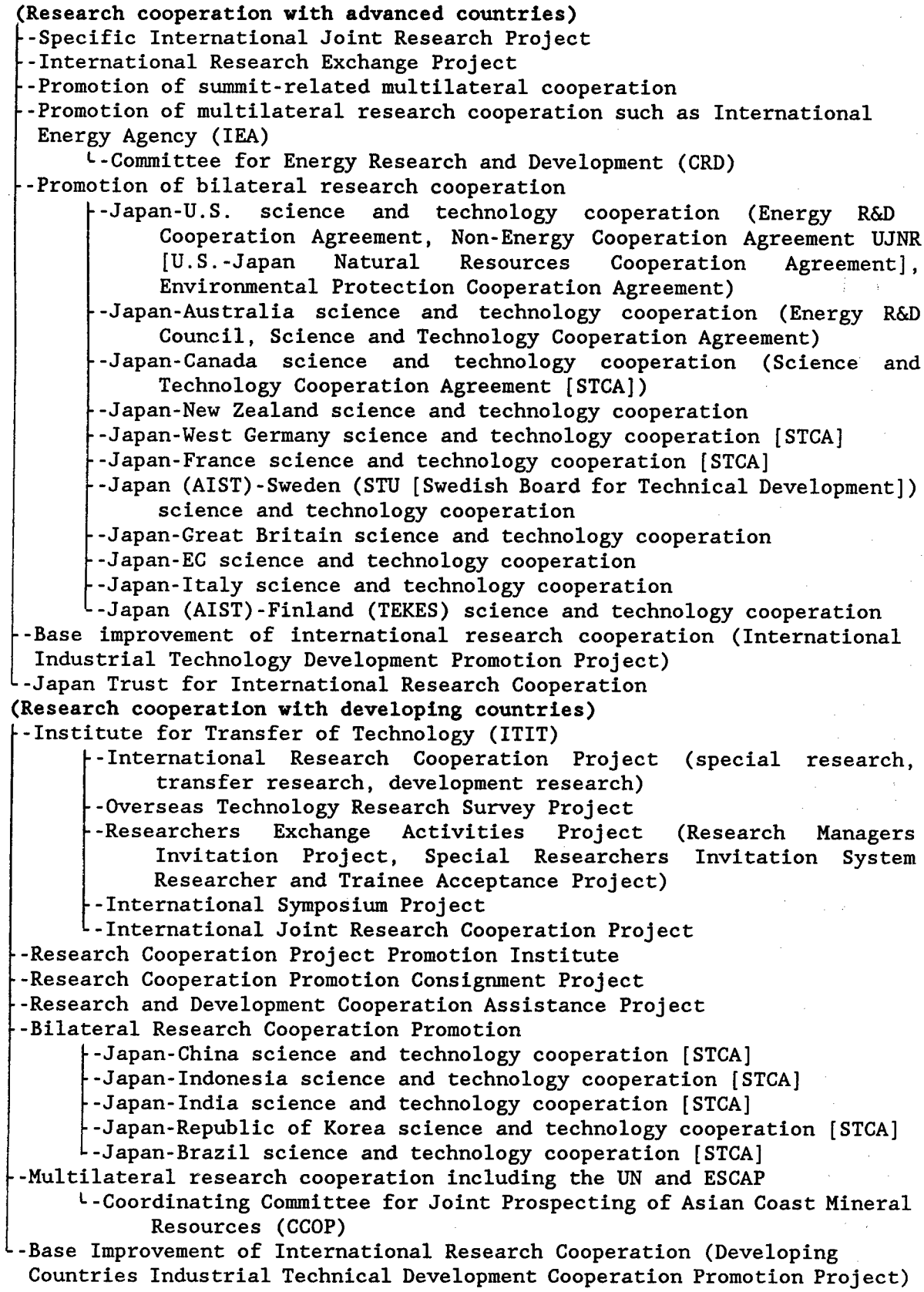

Figure 1. International Research Cooperation Policy System Diagram

2) R&D framework

As for R&D topics where the research content and research capabilities are mutually complementary between overseas research institutes and our own, joint research is conducted in a form that clearly delineates the roles and responsibilities of both parties.

Researchers will be mutually exchanged, and the cost burden from this purpose is shared fairly.

The project will consult with counterpart research institutes on each R&D topic with regard to how to proceed with joint research (research objectives, time periods, attribution of results, etc.).

For the time being, the counterpart organizations are national or public organizations, or organizations corresponding thereto.

(2) International Research Exchange Project

From 1988, along with inviting 20 foreign researchers, especially young researchers, to spend a long period of time (around 1 year) at AIST's experimental laboratories, we will carry out Japanese language training needed for these researchers to live and conduct research in our country. After this training is complete, they will be accepted into the experimental research organizations. In the experimental research organizations, they will engage with Japanese researchers in research projects on basic operations in the mining and manufacturing area.

(3) Positive Advancement of Summit-Related International Research Cooperation Projects

The countries participating in solar power, advanced robotics, and new materials and standards (VAMAS), which are international research cooperation projects agreed to and initiated at the Williamsburg Summit, plan to move forward positively in full cooperation.

(4) Fulfillment of International Cooperation on Energy Technology R&D

We are fulfilling energy-related technology R&D international cooperation by constructive participation in R&D cooperation under the IEA and by the expanding and strengthening of coal liquefaction cooperation between Japan and Australia.

(5) Advancement of the International Industrial Science and Technology Development Promotion Project

The Industrial Cooperation and Technological Exchange Center (a JETRO enterprise), which was established in 1983, carries out, as part of its work, feasibility studies of international joint research and consulting undertakings for the purpose of international cooperation in the advanced technology field, and also works positively to improve the base of international research cooperation.

(With Advanced Countries) (Unit: ¥1 million)

	FY87 budget amount	FY88 budget amount	Remarks
International technology exchange	74	136	General account
--Within Specific International Joint Research Project	(50)	(58)	
--Within the International Research Exchange Project	(0)	(54)	
Japan-Australia science and technology cooperation (coal liquefaction, Sunshine Project)	7,718	6,704	Special account
International Industrial Technology Development Project (Trade Bureau appropriation)	32	30	General account
Summit-related international cooperation projects			
Solar cells, within the Sunshine Project (Sunshine appropriation)	6,943	3,909	General and special accounts
Severe environment function robots, within the R&D of large-scale industrial technology (large-scale project appropriation)	2,425	2,479	General and special accounts
New materials and standards (VAMAS)	44	Undetermined	Science promotion costs (estimate)
Energy Technology Research and Development International Cooperation Project (Sunshine-Moonlight appropriation)	93	85	General account

(With Developing Countries) (Unit: ¥1 million)

	FY87 budget amount	FY88 budget amount	Remarks
International Industrial Technology Research Project (International Trade Policy Bureau appropriation)	183	182	General account
Research Cooperation Project Promotion Institute (International Trade Policy Bureau appropriation)	167	350	General account

[continued]

[Continuation of Figure 2]

	FY87 budget amount	FY88 budget amount	Remarks
Research Cooperation Promotion Consignment Project (International Trade Policy Bureau appropriation)	489	488	General account
Research and Development Cooperation Project Subsidy (International Trade Policy Bureau appropriation)	136	153	General account
Developing Countries Industrial Technology Development Cooperation Promotion Project (International Trade Policy Bureau appropriation)	7	7	General account

Figure 2. General Outline of the Budget

(6) Japan Trust for International Research Cooperation

From the perspective of contributing to the advancement of the world's science and technology and the development of the world's economy, along with working to raise the level of Japan's own technology, by moving forward international research cooperation in the advanced technology field constructively, the Japan Trust for International Research Cooperation (founded in 1985), which uses private sector donations (entrusted for the public welfare), extends invitations to foreign researchers to visit private experimental research organizations.

3. Advancement of Research Cooperation With Developing Countries

From the perspective that the developing countries must absorb with certitude the technology of the advanced countries and must work for efficient permeation of this into their own national industries as their own technology to alleviate the severe economic conditions they now confront, researchers from Japan and developing countries are conducting joint R&D while using the knowledge, experience, and R&D capabilities of the advanced countries on the R&D themes likely to make a major contribution to the development of the developing country. At the same time, the project promotes "research cooperation" that will bring about the increase in research capabilities, which is indispensable for the independent development of the developing country.

Up to now, Japan has been progressing with research cooperation activities like those in Table 1 in accordance with the stage of R&D, and in FY88, Japan plans to expand its projects shown in this table.

Table 1. R&D Stages and Implementing Bodies

Research objective	Subject countries and projects	R&D stage	Research cooperation implementing bodies	FY88 enterprise	
To implement joint R&D to meet the needs of developing countries and to provide them the results, as well as to work to raise the R&D capacity of the developing countries	In principle, each country will implement individual projects	1. Laboratory size	AIST experimental research organization will implement	ITIT	24 projects
		2. Pilot plants	Private sector will implement in accordance with national funds sharing (consignment cost)	Research Cooperation Promotion Enterprise Consignment Institute	6 projects, including research cooperation enterprises relating to manufacture of lightweight construction materials using rice chaff ash; effective use of palm oil
		3. Test plants	Private sector will implement in accordance with national funds sharing (subsidies)	Research and Development Cooperation Enterprise Cost Assistance Project	Enterprise developing film for special agricultural uses
		4. Commercial plant	Private sector implements with private funds		
	Implement basic tasks common to two or more developing countries	5. Laboratory size and pilot plant	AIST experimental research organization and private sector will implement in accordance with national funds sharing (consignment cost)	Research Cooperation Project Promotion Institute	Machine translation system among neighboring countries

(1) ITIT

ITIT has been operating since 1973 for the purpose of carrying out research cooperation in mining and manufacturing technology, which is much in demand from the developing countries, while organically using the research potential of the experimental research organizations of AIST, and by working along these lines, contributing to the fostering of research talent and the raising of research capabilities.

ITIT has proceeded along a path of expansion from a budget of ¥36 million in FY73 to ¥178 million in FY85, from 4 projects to 23 over the same period of time, and, likewise, from 12 to 58 exchange researchers. The number of projects that the institute has worked on up to now is 84 (including those it is working on right now).

In FY84 the institute newly established a joint research project with a number of developing countries; moreover, from FY87, it newly established an international joint research cooperation enterprise for the developing countries to cooperate with advanced countries.

(2) Research Cooperation Project Promotion Institute

This organization concentrates a wide range of experience from Japan's business, government, and academic communities and carries out comprehensive R&D in partnership with other countries to devise radical solutions to basic problems that many developing countries share from among the variety of economic and social problems that the developing countries possess.

In FY88, continuing from the previous year, the institute is advancing research cooperation on machine translation systems to break down the language barrier between Japanese and the local languages, which is indispensable to further Japan's exchanges with its neighbors in particular and to create a greater deal of technology transfer.

(3) Research Cooperation Promotion Consignment Project

This organization carries out applied research, which takes technology at the laboratory level and transforms it into industrial processes, by establishing pilot plants in local areas and leading the researchers of the partner countries in joint operational research. In FY88, in addition to four extant projects, including the manufacture of light-weight materials made of rice chaff ash (in cooperation with Malaysia), the organization launched two new projects: the development of water preserving agents in dry belts (in cooperation with Egypt) and a regional fuel cell generator system (in cooperation with Thailand).

(4) Research and Development Cooperation Assistance Project

This organization assists research cooperation at the test stage which private sector organizations are conducting. It began full-time work in FY88 (in cooperation with China) on a project developing film for special agricultural uses.

Research project name	Implementing research institute	Partner countries, partner organizations	Research period	Research summary
Research into synthesis of anion dope quartz glass and an understanding of defects in its structure	Electrotechnical Laboratory	France, Sacre Nuclear Energy Laboratory	1985-89 (5-year period), continuous	This work develops technology to mix (dope) anions such as fluorine in order to compensate for defects in quartz glass, which is used in semiconductor insulation film, and creates higher performing quartz glass
Research into ultrahigh sensing technology which uses high stability lasers	Instrumentation Research Institute	West Germany, Physical Engineering Laboratory	1985-89 (5-year period), continuous	To develop technology using laser optics with highly stable wavelengths to analyze energy within atoms and molecules at a high degree of resolution and sensitivity, and thereby contribute to the development of advanced technology and quantum measurement standard
Research into heat-resistant carbon ceramic complex materials and their characteristics under high temperatures	Kyushu Engineering Laboratory	West Germany, Aerospace Research Institute	1986-89 (4-year period), continuous	To develop carbon ceramic complex materials with superior high temperature characteristics, such as heat resistance and fatigue at a high strength, as compared to previous carbon materials
Research into optical micro-gas sensors	Osaka Engineering Laboratory	Belgium, Rouen Catholic University	1987-90 (4-year period), continuous	To detect gas density using optics, conduct development of an optical gas detection element to transmit detection signal as optical signal, and to develop small highly reliable gas sensor superior in explosion prevention and noise resistance

[continued]

[Continuation of Figure 3]

Research project name	Implementing research institute	Partner countries, partner organizations	Research period	Research summary
Research into development of precision evaluations of new superconductors and precision measurement devices	Electrotechnical Laboratory	United States, Bureau of Standards, Department of Commerce	1988-92 (5-year period), new term	While evaluating precisely new superconductors and conducting R&D into high quality new superconductors, to advance R&D into devices using precision measurement instruments such as high performance Josephson elements and SQUID elements.

Figure 3. FY88 Specific International Joint Research Project (Estimate)

(5) Developing Countries Industrial Technology Developing Cooperation Promotion Project (Trade Bureau Account: General Account)

This organization uses the functions of the Japan External Trade Organization to carry out seminars on such topics as the dissemination of the result of research cooperation that AIST has implemented, surveys on the needs for research cooperation, and consulting, in order to give constructive assistance to the development of the industrial technology of the developing countries, such as the ASEAN countries, and to contribute to the rise of research potential in developing countries and the facilitation of trade with developing countries.

12259/9365

Internationalization of Electronics Industry and Its Impact

43063037 Tokyo DENSHI KOGYO GEPPO in Japanese No 7, Jul 88 pp 2-6

[Commentary by General Affairs and Planning staff of Japan Electronic Industry Development Association]

[Text] Introduction: Japan's electronics industry has acted to enhance and strengthen overseas production and attempted to further internationalization as a measure to relieve trade friction and to counter the reduced competitiveness caused by the rapid rise of the yen. However, there is apprehension that the rapid transfer of manufacturing bases overseas will bring a reduction of domestic production and employment opportunities and that production capacity within Japan will drop--what is called the hollowing out of industry.

For that reason this association decided to carry out, as a part of its program for FY 1987, a systematic study, to include overseas surveys, of the problems related to internationalization of the electronics industry; the Electronics Industry Internationalization Study Committee (chaired by Takeshi Ishiguro of the Japan Economic Research Center) was established at the end of April, 1987. In addition to meeting monthly, this committee sent survey teams to 5 Asian NIC's in November and spent a year in an energetic study to study the activities of companies with Japanese capital and to understand the latest situation overseas. Now the results of the survey have been drawn up, and a summary is presented in these pages.

The Internationalization of the Electronics Industry

1. Trend of Internationalization: Japanese exports of electronic products have grown 35-fold in the past 20 years, and have reached the level of about Y8 trillion. The export ratio has climbed to 50 percent. Imports have grown about 20-fold, and have reached the Y1 trillion level. The import ratio has climbed to about 10 percent.

To break down exports and imports, there has been little export growth for comsumer equipment compared with that for industrial equipment and electronic parts, but imports of consumer goods have grown. In the case of industrial equipment, on the other hand, exports have grown more than imports, and the Japanese electronics industry has shown development and improved capabilities.

In the field of electronic parts, both the export ration and import ratio have shown great growth; interdependence among nations has gone forward.

The strengthening of the yen since 1985 brought about the phenomena of stagnation of exports and growth of imports, after an initial drop-off, when measured in yen. The overall flow, however, has just been a slight acceleration of the improved capabilities of Japan electronics industry in the form of an increased proportion of industrial equipment and reduced emphasis on consumer equipment.

In addition to the growth of exports and imports of individual products, there has been increased spread of manufacturing overseas. The number of companies in overseas markets reached about 400 in 1987. They went primarily into the developing countries of Asia and Latin America in the first stages, and have shifted to the advanced countries of North America and Europe recently.

2. Pattern and Background of Internationalization of Companies: A number of patterns can be seen in the penetration of companies overseas, in accordance with differences in the times that penetration began and consequent differences in business conditions. It is asserted that the penetrating countries can be generally classified by nationality as European, American or Japanese, and that such patterns as a "multi-domestic strategy" by European companies, a "multinational strategy" developed by the multinational companies of the U.S. and a "global supplier strategy" by Japanese companies can be observed.

The global supplier strategy is, to put it bluntly, the pattern of overseas penetration in which high productivity (high quality and low cost) is achieved with Japan as the single production base, using that to offset the additional costs involved in exports, and supplying products to markets throughout the world.

The international development of European and U.S. multinational enterprises is explained as reference material for the globalization of Japanese companies. There are three models--American, European and Japanese--of multinational enterprises, and differences are pointed out in regard to such factors as motivation for penetration, penetration elements, mode of development, production strategy, organization and restructuring toward growth sectors. The U.S. companies, for example, are characterized by use of superior product technology, penetration for the purpose of establishing control over systems and software, and production strategies that include outsourcing and OEM procurement. European enterprises are characterized by absorption and joint ventures in order to draw close to large markets. In certain countries they have shifted from dispersed management to matrix management to optimize product strategy for companies that have been purchased there. The European and U.S. enterprises have not adopted the Japanese practice of expanded development of the home company's own business activity. Instead they tend to change to growth enterprises by restructuring through M&A and tie-ups with other companies.

Brief case studies were made of IBM, Phillips and ATT to show concrete examples of the points mentioned above.

3. Elements in the Encouragement of Globalization of Companies: Because of the strong export orientation and international competitiveness of the economy of Japan, a large surplus has continued in the current account, and now Japan has become the world's biggest creditor. On the other hand, these factors have created an economic imbalance of global scale, accompanied by yen appreciation and trade friction that have been conspicuous in recent years. Exchange rates and coordination of economic policies among the G7 countries have been used to correct this economic imbalance, but that has inevitably pushed Japanese companies in the direction of globalization by means of overseas production and importation of people and products.

The following are mentioned as immediate factors that have encouraged globalization in recent years.

(1) Overseas penetration by Japanese companies with high export ratios has been accelerated by the severity of yen appreciation and trade friction.

(2) The international development of free competition has been accompanied by increased international interdependence in regard to OEM supplies, technology transfer, joint research and so on.

(3) Rapid technical innovations in the area of manufacturing technology have enabled early stabilization of local production overseas.

(4) The development of data communications networks and transport networks have enabled management strategies on a global scale.

(5) More efficient production of software has enabled both worldwide integration and diversification for the cultures of individual countries.

(6) Preferential measures and deregulation, primarily in North America and the NIC's, have created a favorable climate for investment.

Japanese Penetration and the Electronics Industry in Asian NIC's

Asian NIC's have achieved rapid growth through expansion of exports, primarily of electronics products. Considering that the population of these countries is more than 80 percent that of Japan, there is a good chance that the scale of the electronics industries in these countries will become even greater. As this happens, the division of labor relationship with Japan will become stronger.

As a part of its internationalization, the electronics industry of Japan has established a number of production bases in Europe. Faced with exchange rate revaluations with Asian countries and rising labor costs in addition to the yen appreciation of recent years, Japan has seen unprecedented activity in penetration from Japan to the NIC's and ASEAN countries, and also in spreading to other regions from bases in the NIC's. In South Korea and Taiwan, there is little opportunity left for production of labor-intensive products to take advantage of low wages; it is the policy of both countries to shift to the field of more advanced technology. It is the same in Hong Kong and Singapore,

but because of the good site conditions in those countries, they will increasingly function as control centers for the PRC and the Asian region. Thailand and Malaysia are still suitable as bases for production of labor-intensive products.

Two characteristics of direct investment by Japanese companies are the concentration on exports to third countries and the low rate of local procurement of parts and materials; the governments of various countries have sought improvements from the Japanese companies. On the second point, there have been active moves to engage in local procurement in connection with the appreciation of the yen. Another characteristic of Japanese companies is management from a long-term perspective, and they have earned praise for their development of industry and transfers of technology at overseas sites. This way of thinking, as a part of internalization, has been well-received throughout the world.

This study of Asian NIC's points out that the management of foreign subsidiaries of Japanese companies tends to center on Japanese officers, and the delegation of authority from the home office is still inadequate. The view is expressed that it is necessary to handle matters in the manner of European and U.S.-style contractual companies.

Japanese companies are thinking about their management systems on the basis of their experience with foreign projects in the Asian region and circumstances in individual countries. While incorporating the Japanese system into the management of local subsidiaries, they will relax the management systems they have been using and go forward with an internationalization and diversification that differ from the practices of European and U.S. companies.

Progress and Future Trends of the Globalization of Japanese Companies

1. Status of globalization of Japanese companies

(1) Status of globalization of major equipment manufacturers: The trend of globalization of electronics companies has been greatly accelerated by recent trade friction and the sharp appreciation of the yen. But looking back, these companies have a history of nearly 30 years of overseas activity; while such movement is natural, it is closely related to external factors such as the economic climate surrounding the companies.

Looking at overseas project development on a region-by-region basis, we can discern the characteristics of each region. Enhancement of the sales function is the dey in North America, along with strengthening of the production function. A low cost lever is sought in Asia, so development has centered on the production function. In Europe there had been development emphasizing sales in order to strengthen the country-by-country sales system, but the production function has been strengthened sharply since the beginning of the 1980s because of the intensification of trade friction.

The overseas development of Japan's electronics companies, while affected by a variety of external climates, has generally gone through three stages: (a) foreign development of the sales function, premised on the export of products

produced domestically; (b) the transfer overseas of some company functions, centering on the production function; and (c) a search for optimization through development on a global scale of such company functions as R&D, production, sales and financing.

(2) Status of globalization of manufacturers of electronic parts: Overseas penetration by electronic parts manufacturers has expanded from the the Asian region to that of North America, to Latin America to Europe. The status of penetration by electronic parts manufacturers can be characterized by saying that in North America the sales and production functions are about equal, with Asia being the region of the production function and Europe the region of the sales function.

All in all, it is hard to say globalization has begun within the overseas penetration by electronic parts manufacturers. But with the increased overseas production by home appliance manufacturers, the biggest users of electronic parts, and with the consequent globalization of those companies, the electronic parts manufacturers will become involved, like it or not, and will have no choice but globalization.

2. Future Trends of Globalization by Japanese Companies

(1) Structure of global logistics: To facilitate the supply and procurement of materials for a production function deployed on a global scale, companies have intensified international moves to expand procurement of materials (such as establishment of an International Materials Procurement Center) and have intensified reimports of intermediate and finished products and exports to third countries. They are also moving toward an international division of labor among regions.

It has accordingly become an urgent task for each company to create a global logistics structure to link companies. Moves to establish and effectively operate such a structure are being intensified.

(2) Global information network trend: In order to link organically the management functions of sales, production development, distribution and financing, which have expanded to a global scale, and in order to carry out decision making most efficiently, it has become essential that a global information network structure be established. Japanese electronics companies have gambled their survival and and are gradually spreading information networks through the world; it is thought such moves will continue to be expanded and intensified.

(3) R&D globalization trend: Compared with Europe and the U.S., Japan's R&D excels at product development, what is called applied research, but is inferior in the field of basic research. There have been calls for Japan to make an international contribution, befitting its international status, in the field of basic research. With consideration to sharing the risk of basic research investment and to an efficient response to ever-larger projects, there is increasing support for joint research among Japan, the United States and Europe. Japan should, as a matter of national policy, go forward with globalization of basic research.

Globalization of R&D by companies that have specialized in applied research is taking the course of deployment of research divisions to foreign locations and international joint R&D, the course of division of labor, or a combination of the two.

(4) Trend of globalization of fund procurement and use: It is coming about that, taking Europe as a single zone, financial bases are being established there, where they are made the centers of information networks, and from which procurement of funds and management in multiple currencies take place in a comprehensive and concentrated manner.

In the United States too, many companies have financial bases in the form of local corporations dispersed as centers of large areas that are going online and are managed intensively.

(5) Trend of globalization of personnel: Companies have begun to emerge that try to use the personnel resources of the company group as a whole by putting the right man in the right job, whether he is Japanese or a local. The idea of internationalizing personnel by employing foreigners at the home office in Japan or detailing them to companies in Japan, and by increasing promotion of local employees to the top ranks, is rapidly gaining popularity.

(6) World headquarters/Regional headquarters concept: Among the companies that represent the Japanese electronics industry there are some that have worked out a concept in which one world general headquarters company coordinates the efforts of four regional headquarters in Japan, the U.S., Europe and Asia. The regional headquarters have an understanding of the characteristics of their regions, and are able to strengthen management control of local projects.

3. Framework of Globalization Strategy: Globalization is a matter of a company planning and coordinating activities from a worldwide perspective in an attempt to strengthen its management base.

An essential element of globalization is that the company deploy, from an international perspective, activity units in a way that will achieve optimum fusion with worldwide resources, so as to take advantage of elements of competitive advantage as they change over time, and to foster a strong interdependence among these units by establishing and maintaining independent competitive superiority in each unit. This process will bring with it management synergy and heighten the international competitive status of the combination of units. Making such an attempt constitutes a global strategy. It is important, as a part of strategic policies, to assure the efficiency of operation of the combination, its responsiveness to markets and the ability of activity units to learn from each other. The primary design parameters within those policies are the acquisition, distribution and activity level of activity units, the extent of each unit's authority and the method of coordination among units.

The major elements of strategic policy to be considered in connection with the first design parameter are the complexity of product technology (determining

the length of the process), the degree of economy of scale of production, differences in market characteristics, and the scale of the market. The major elements in connection with the design of authority and coordination are the degree of interdependence among activities in physical activities, and the degree of interdependence for knowledge and information. The preferred structure for the combination of units can be built by starting with these elements, then designing the parameters from the three criteria (efficiency, responsiveness and ability to learn).

Economic Impact of Internationalization and Response to It

It is clear that the appreciation of the yen in recent years has encouraged penetration overseas by Japanese companies. However, companies have made every effort to maintain domestic employment by shifting to higher value-added products, changing deployment of capital and taking foreign orders for domestic production.

The experience of industrial stagnation in Britain and the United States has taught us about company management problems such as deterioration of the entrepreneurial spirit, the lack of export incentive and reduced interest in the personal use market, about labor-management and industrial organization problems, and about the importance of the macroeconomic policies of supply-demand balance, interest policies and exchange rate policies. To maintain a base for business during the spread of internationalization, it is important not to let go of the key portions. It is therefore necessary to go forward with R&D in step with outsiders.

The companies themselves, aware of coexistence with local companies in the markets they have penetrated and of the possibility of long-term separation, have undertaken flexible reviews of organization in the midst of internationalization and they have striven to use economic resources more efficiently. So that the internationalization of Japanese companies can go forward smoothly without placing a burden on the domestic economy, it will be important to manage fiscal and monetary policies to avoid wild fluctuation of interest and exchange rates. Japan will also need an industrial policy that includes creation of domestic investment opportunities and support for technological development that makes a greater international contribution. A response to the imbalance in domestic labor supply and demand that has accompanied the opening of the domestic market and moves to foreign markets will be necessary to promote the internationalization of companies and to facilitate domestic industrial coordination.

In the long term, it will be best to take advantage of the companies' own management resources and build a worldwide relationship of mutual use of those resources, and thus contribute to international society and help activate the world economy.

We have introduced the main points of this study above. For the details, please attend the "Seminar on Internationalization of the Electronics Industry and Demand Trends" to be held in September, or obtain our report No. 63-E-48.

9601

First International Symposium on Superconductivity

Greetings Message From S. Tanaka

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 1

[Article by Shoji Tanaka, vice president, International Superconductivity Technology Center (chairman, Steering Committee)]

[Text] We welcome your participation in the first International Symposium on Superconductivity (ISS '88), sponsored by the International Superconductivity Technology Center (ISTEC).

Since the great potential of high-temperature super-conductive materials was first suggested in the spring of 1986, R&D has been active not only in Japan but in the rest of the world as well. As a result, superconductive materials with a critical temperature of 125K, higher than the boiling point of liquid nitrogen, have been confirmed. R&D in superconductivity is expected to make continuing progress in the areas of materials research, theoretical analysis, and development and practical applications of process and processing technology.

For the scientists and engineers in the superconductivity field assembled here, ISS '88 will provide a forum for international exchange in research through lectures on wide-ranging themes, panel discussions and poster presentations.

The Steering Committee of ISS '88 hopes that all who are attending this Symposium will join in to form active interchanges of information on the latest findings, as well as discussing prospects for the future during these sessions. In that way, ISS '88 will best serve the promotion of international cooperation.

In closing, we highly appreciate the kind support rendered by Aichi Prefecture and the City of Nagoya, the venue of the Symposium, and that of the Ministry of International Trade and Industry and related academic societies.

Organization, Committees

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 pp 2-3

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Abstracts of Papers Presented

Development of Superconducting Materials and Impacts on the Social Economy

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 31

[Abstract of paper by Tsuneo Nakahara, executive vice president, Sumitomo Electric Industries, Ltd.]

[Text] Since the discovery of high-Tc superconducting oxides much basic research has been conducted in the areas of new materials, structural analysis and theoretical analysis, as well as process research for applications.

In this presentation an outline of the present state and future problems to be solved in film and wiring technology will be given. They are key factors in application research. In film technology, high-jc films of Ln and Bi systems which have more than one million A/cm^2 critical current density at a liquid nitrogen temperature, have been developed. These have opened the door for the subsequent development of practical application of high-Tc oxide superconductors. Powder, melt, and film, three major methods used in wiring technology, will be reviewed.

In conclusion, possible impacts of a liquid nitrogen and/or no refrigeration system on future industries will be discussed, and superconductivity commercialization will be compared to present metallic superconductivity applications.

Application to Electric Power System

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 32

[Abstract of paper by T. Mitsui, Tokyo Electric Power Co., Inc.]

[Text] The electric power system is composed of the generation, transmission, transformation and distribution facilities, and the user facilities. The loss of electric energy caused due to these facilities is then considered.

Several applications that can be thought of are for electric power systems, generators, transmission cables, transformers and storage facilities.

equilibrium is achieved, but then the equation which describes the movement of U isotopes becomes nonlinear.

2) It is possible to linearize this nonlinear equation through the substitution of suitable variables and by doing so, an analytical solution is obtained by providing the boundary conditions.

3) Good agreement is seen between the analytical solution and experimental values in nonlinear enrichment domains. This is thought to show the constancy of hypothetical equilibrium stage height and enrichment factor and the adequacy of boundary conditions.

Symbols

c_1: concentration of solution phase elements not in question
c_2: concentration of solution phase elements in question, C: c_1+c_2
f_1: concentration of solid phase elements not in question
f_2: concentration of solid phase elements in question
F: f_1+f_2, α: space gap ratio
$\bar{x}$: solute solid phase proportion
$K = 1+\epsilon_s$

Symbols for Equation (1)

$k = (v_A-v_B)/D_A-D_B)$
$\kappa = (v_AD_B - v_BD_A)/(D_A - D_B)$
c: constant
D_i: diffusion coefficient for component i
RA^0: molar fraction for supply isotope A
$R_A(x,t)$: molar fraction for isotope A at position x for time t
v_i: velocity for component i
xp: distance from the origin (x = 0), R_A^0, to $R_A(x,t)$

Symbols for Equation (2)

$$\gamma(s_j)=\sqrt{\left\{\frac{(\theta_1+\theta_2)s_j}{\sigma}+(K+1)\right\}^2-4K}$$

$$\phi(s_j)=\sqrt{\frac{(\theta_1+\theta_2)s_j/\sigma-(K-1)}{\gamma(s_j)}}$$

$$\delta(s_j)=\frac{(\theta_1-\theta_2)s_j-\sigma(K-1)}{2}$$

$\theta_1=\varepsilon H/L$, $\theta_2=(1-\varepsilon)h/l$

$\sigma=k/L$

Symbols for Equation (3)

t: time (s), u: solution flow rate (cm/s)
$\bar{u}$: U adsorption band migration speed (cm/s) = b+($\tilde{u}$+u)
$\tilde{u}$: solution space column speed (cm/s)
α: Separation factor, S: total number of plates
s: number of stages from the bottom end

a: resin volume occupancy rate
b: solution phase volume occupancy rate
h: unit separation stage height (cm)
β: U concentration ratio for the resin solution phase
$\gamma = \epsilon S/\pi$, $X = \epsilon^2\tau$
$2\epsilon = \alpha - 1$, $\tau = u^*t/h$
$u^* = \tilde{u}/(a\beta+b)$

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13008/9365

Developments in Post-Irradiation Testing Technology

43062574 Tokyo GENSHIRYOKU in Japanese May 88 pp 50-55--FOR OFFICIAL USE ONLY

[Article by Atsushi Sakakura, Haruyuki Sakai, and Akira Yamamoto, members of the Material Test Reactor Department, Japan Atomic Energy Research Institute: "Post-Irradiation Testing Technology Recently Developed"]

[Text] **1. Introduction**

Post-irradiation test facilities, generally called "hot labs," are used to conduct various kinds of examinations and tests designed to meet specific objectives. In particular, they are used to investigate physical or chemical changes produced by irradiation in nuclear reactor fuels and materials, all of which are irradiated in nuclear power reactors and/or test and research reactors. The practical fuel test facilities of the Japan Atomic Energy Research Institute (JAERI), the NED hot lab facilities of the Japan Nuclear Fuel Development Corp., and the latest fuel hot lab constructed by Mitsubishi Heavy Industries in 1986 are typical of the post-irradiation testing facilities that handle nuclear fuels for power reactors in Japan. The Oarai Engineering Center of the Power Reactor and the Nuclear Fuel Development Corp. has been equipped with irradiation fuel assembly testing facilities, irradiation fuel test facilities, and irradiation material test facilities. These have all been constructed to confirm the soundness of the constructural components that will be irradiated in the core of the experimental fast-breeder reactor "Joyo" and to develop fuels and materials for the prototype reactor "Monju." Post-irradiation test facilities designed to test the fuels and materials to be irradiated in a test research reactor have been installed in the hot lab facilities constructed by Tohoku University, Nagoya University, Kyoto University, and the Tokai Research Institute and JAERI's Orai Research Institute. In addition, Mitsubishi Heavy Industries has constructed hot lab facilities to test irradiated materials for the Tokai testing ground of the Takasago Research Institute.

These facilities have been designed and constructed for the purpose of examining and testing samples of the materials to be handled and are equipped with examination and test equipment. State-of-the-art technologies have been adopted for the design and manufacture of these examination and test instruments and equipment. At the same time, various

kinds of technologically innovative units that have been upgraded in proportion to the increase in operational know-how gained from practical operations are being installed. Every possible effort is being made to develop a new test technology and to improve it. This goes hand-in-hand with the progress being achieved in nuclear research based on practical applications.

The scope of post-irradiation testing technology in terms of samples to be handled covers many fields, ranging from a light water duel assembly reactor that is about 4 meters in length or an experimental fast-breeder reactor fuel assembly to a transparent electron microscope 3 mm in diameter. The tests include various kinds of examinations, such as bringing in and shipping samples to the facilities, nondestructive tests, destructive tests, and fine structure and component analysis. They also include remote control technologies for the operation and maintenance of the facilities, control mechanisms to ensure the safety of the workers by reducing exposure, and technological problems with regard to the effective practice of examination and testing.

Articles about these test technologies have appeared serially in this magazine, ranging from Volume 9 to Volume 13,[1] while information about the design and operation of the facilities has been introduced in the academic review of the Atomic Energy Society of Japan and other similar technological reviews.[2-4] To avoid unnecessary repetition in this report, therefore, the authors would like to outline the post-irradiation tests currently being carried out in the hot lab facilities of JAERI's Orai Research Institute and to discuss several test technologies.

2. Post-Irradiation Test in JMTR Hot Lab

The Japan Material Test Reactor (JMTR) constructed by JAERI is widely used to conduct irradiation tests of nuclear reactor fuels and materials, and to produce radioactive isotopes. Furthermore, it has recently been used for re-irradiation tests of light water reactor fuels. To fulfill this testing program, the reactor operates on a system of four to five cycles a year, where 22 days of operation at 50 MW of thermal power are defined as one cycle.[5,6] The lab facilities are connected to the nuclear reactor pool through a canal that is 6.2 m deep. The encapsulated fuels and materials, after being irradiated, are brought into the hot lab facilities through the canal.

As illustrated in Figure 1, the hot lab facilities consist of eight cells sheltered by heavy concrete, a fuel test cave comprising four lead-sheltered electron microscopes, seven lead-sheltered cells and a material test cave comprising five steel-sheltered caves. In the hot lab facilities, various kinds of post-irradiation tests are carried out using the test items and flow pattern illustrated in Figure 2 based on the applicability of the testing machines or remote-controlled equipment installed in each cell.

The sealed capsules brought into the facilities are opened and disassembled by the application of a cutter, and an irradiation test sample is picked

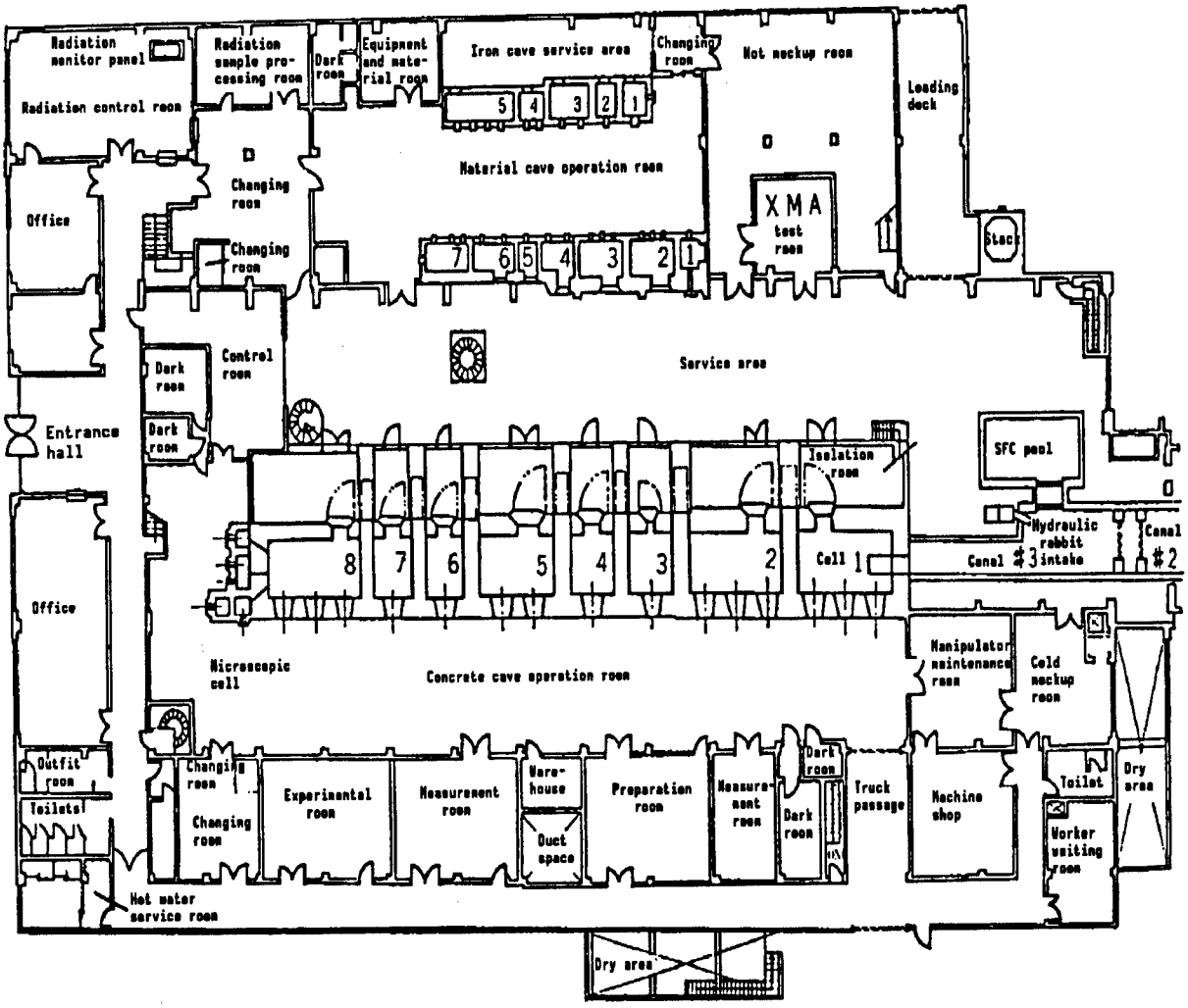

Figure 1. JMIR Hot Lab Facilities

up from there. The fuel samples undergo nondestructive inspections--such as visual inspection, X-ray inspection, and gamma scanning--in the concrete cell. Other tests include the collection and analysis of the gases discharged by the fission of fuels within the fuel rod, measuring the density of fuel pellets, and destructive tests, such as metallurgical tests. The material samples are picked up from the capsule and transported into the material test cave where they can be subjected to a number of strength tests including tensile tests, impact tests, fracture toughness tests, dimensional measurement, electric resistance, and fracture observation.

The authors would like to introduce some recently developed testing technologies, such as an eddy current test, a fuel rod dimensional test, gap measurement and capsule reassembly technologies. Material-related technology will be discussed in the next issue.

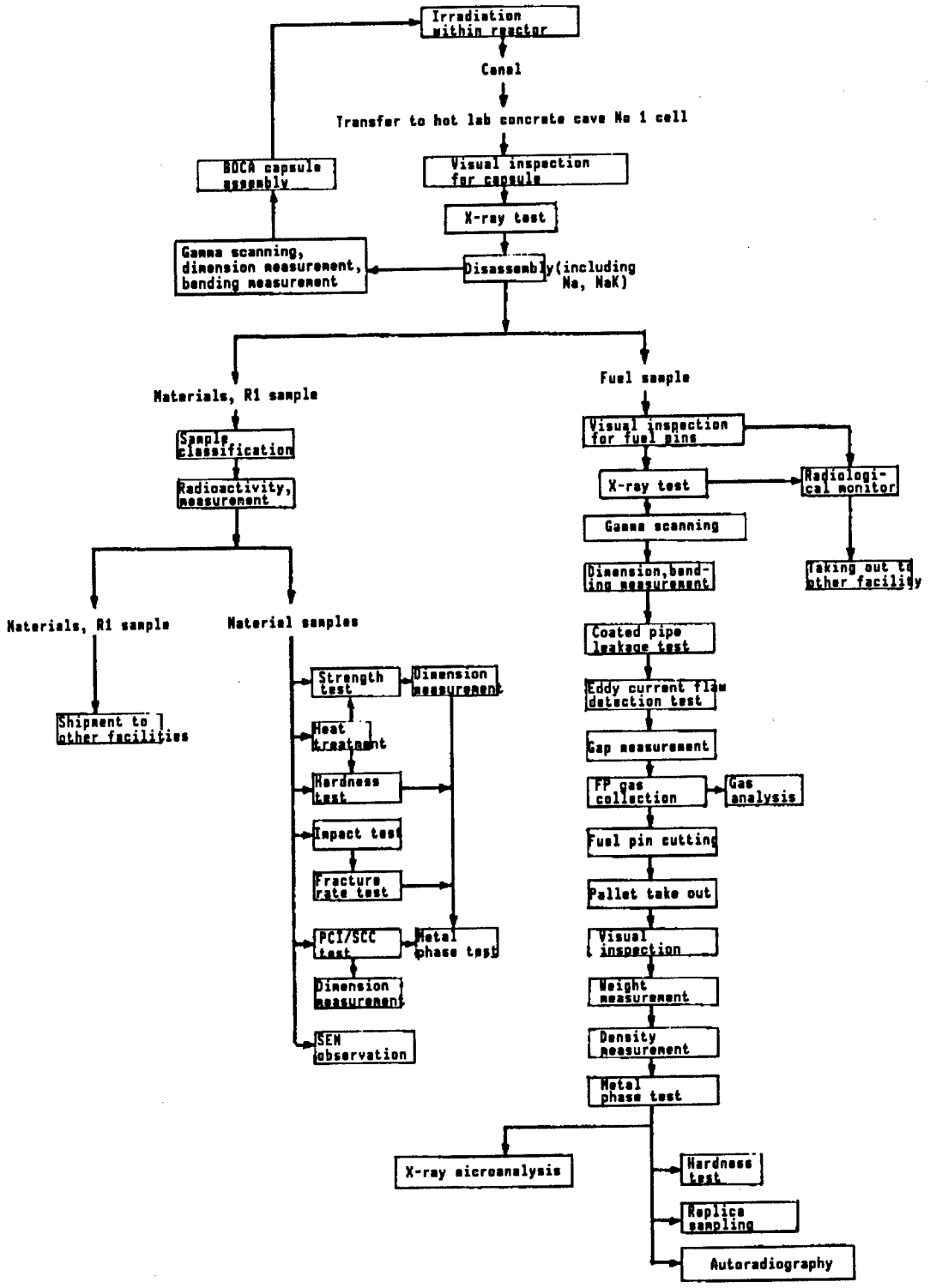

Figure 2. Post-Irradiation Test Flow

3. Eddy Current Test Technology

There are many methods available to detect defects in a coated fuel pipe, including X-ray tests, leakage tests, and the like. However, the eddy current test is believed to be more effective in detecting fine cracks or unpierced faults. It has become indispensable as a post-irradiation test.

The principal of fault detection used in the eddy current test is based on the application of a conductive current (called excess current) that is produced in a metal plate conductor in the form of a concentric circle when an attempt is made to place a coil through which an alternating current is passed close to the plate. When a defect or variation in the material of the plate is present, the excess current is changed and the impedance of the coil increases or decreases in proportion to this change. Therefore, the presence of a defect can be detected by moving the metal plate and measuring the change in the impedance. The intensity and distribution of the excess current varies with the distance between the coil and the sample being tested, the shape and the material of the sample being tested, and the presence of a defect.

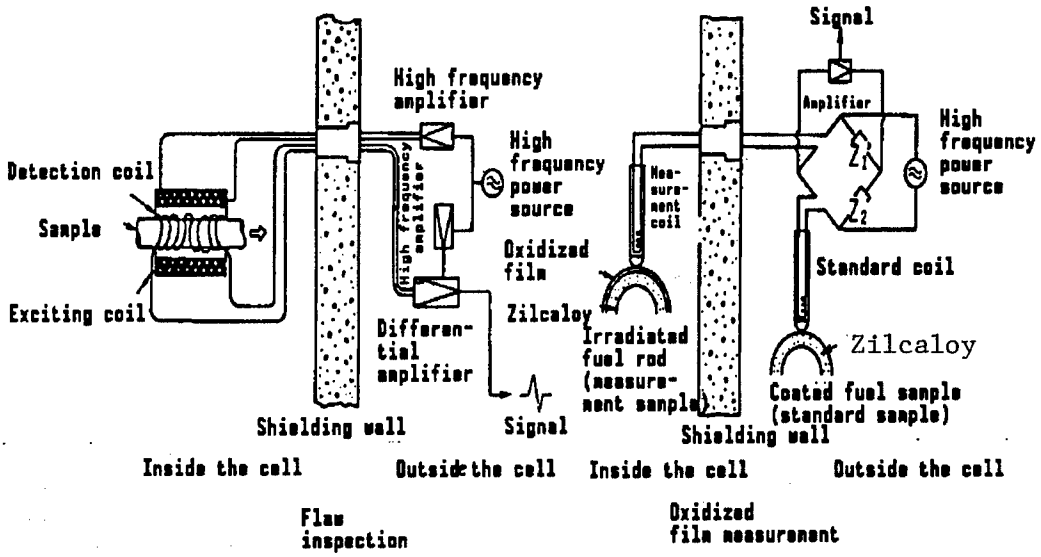

Figure 3. Eddy Current Test

As illustrated in Figure 3, the test unit is designed to detect a defect on the coated fuel pipe by allowing the detection coil to pass through the shielding wall or by moving the fuel rod in front of the wall. This test unit allows the selection of two kinds of coils and makes it possible to locate the position of a defect in a fuel rod in the axial direction with a pierced-type coil or in the axial and peripheral directions with a probe-type coil. When processing the signal data obtained by axial scanning using a probe-type coil, it becomes possible by changing the peripheral position to generate a three-dimensional image of the distribution, as illustrated in Figure 4. This makes it possible to fix the position of the defect in both the axial and peripheral directions.[7] This test makes it

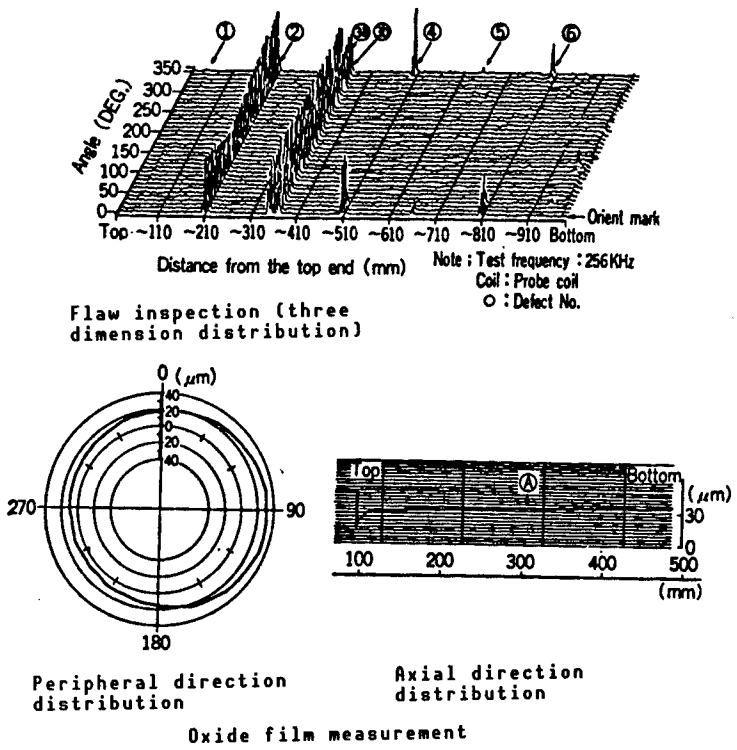

Figure 4. Example of Eddy Current Test Data

possible to locate defects within 5 percent of the wall thickness of the coated pipe. It can also discriminate between the shape and size of a defect and the inner and outer surfaces of the coated pipe.

When an attempt is made to measure the thickness of the oxide film on the coated pipe surface formed during the irradiation operation, variations in the thickness of the oxide film change the distance between the coil and the coated pipe, which produces variations in the coil impedance. The thickness of the oxide film can be determined by measuring this change. Specifically, the thickness of the oxide film can be determined with an accuracy of ±0.005 mm by comparing the output level of the signal with the output level of the standard sample (the coated pipe with no oxide film).

4. Fuel Rod Dimensional Measurement Technology

The dimensional measurement methods carried out in the cell include the measurement of samples on a level block with a dial gauge, length measurement with a linear scale, micrometer-based measurement and optical measurement using a periscope. In this article, the authors would like to describe the dimensional measuring unit, which uses a magnetic scale to measure fuel rods in the hot lab facilities.

The magnetic scale is a length measuring system based on magnetic record regeneration technology. It uses a very accurate scale which has recorded magnetic patterns of fixed wavelength on ferromagnetic materials. Since

the probe detects the magnetic patterns of the scale and converts them into electric signals, long samples can be measured with a high degree of accuracy.

Figure 5 shows an outline of the system. As illustrated in the figure, the sample is fixed by upper and lower chucks installed on the rack within the cell. Two magnetic scale probes are used to detect the deviation by scanning over the full length. The length of the sample and its axial measuring position can be determined by detecting the travel of the probes through the use of an encoder. The diameter and the bending of the sample can be determined by detecting the deviation of the three magnetic scale-based probes. In addition, the circular deviation can be determined by rotating the sample. The accuracy of the length is ±0.002 mm; the accuracy of the diameter is ±0.005 mm. The accuracy of the bending measurement is ±0.02 mm and the accuracy of the circular deviation measurement is ±0.0005. All measurement data are stored in the personal computer. As the need arises, the stored data can be drafted or reproduced as the outside diameter of the fuel rod and the degree of bending over its full length or the circular deviation of the fuel rod.

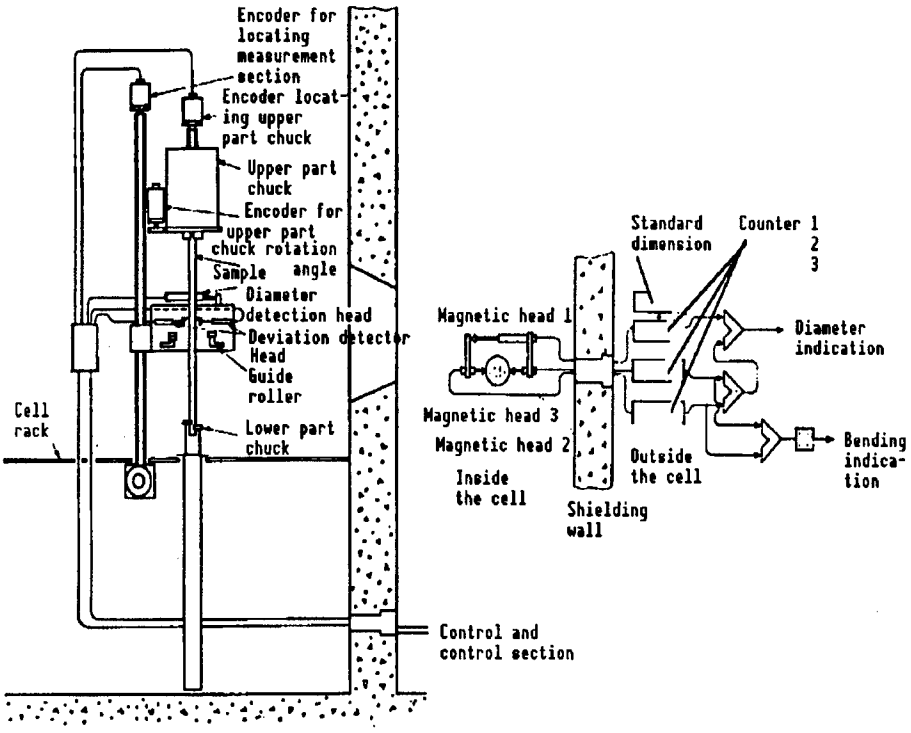

Figure 5. Fuel Rod Dimension Measurement Unit

5. Gap Measuring Technology

In general, a gap of about 0.2 mm between the fuel pellet and the coated pipe is created during the manufacturing process, but the gap varies with the shrinkage, rearrangement and swelling of the pellet during the irradiation work. The post-irradiation gap can be measured by compressing

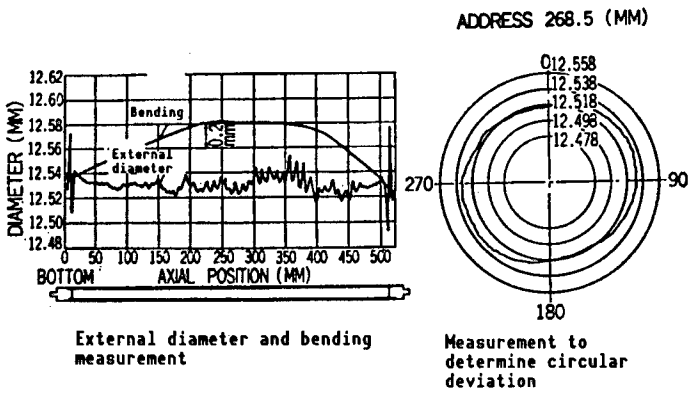

Figure 6. Example of Fuel Rod Dimension Measurement Data

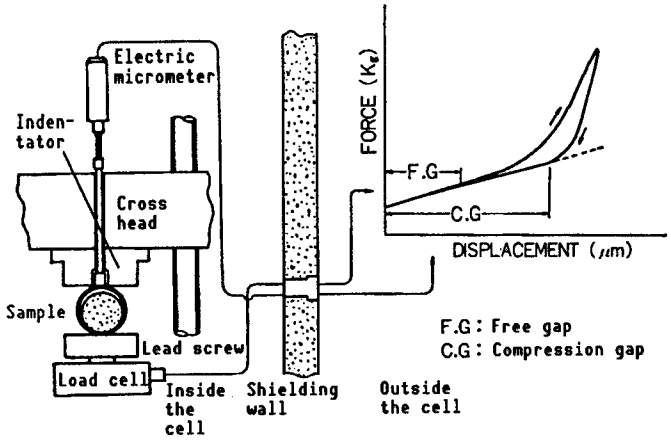

Figure 7. Fuel Rod Measurement Gap

the fuel rod from the outside and detecting the distance needed to bring the fuel rod into contact with the pellet.

As shown in Figure 7, the measuring unit uses a small compression tester. It compresses the specified position of the fuel rod with a load of 250 kg and a smaller load in the diameter direction, and deforms the coated pipe within the elastic limit. When the compression load is detected with a load cell and the relation between load and deformation is detected with an electric micrometer, the curves indicated in Figure 7 can be obtained. When an attempt is made to apply the load to the coated pipe continuously, assuming that the ordinate axis denotes load while the abscissa denotes displacement, the fuel rod is subjected to a linear change in the initial stage. When it comes into contact with the pellet, the curve gradually begins to rise. The displacement up to the inflection point can be measured as a free gap (FG). Then, with an attempt is made to eliminate the load, a curve different from that during load appears, which quickly returns to the original straight line. As a result, displacement up to the point of inflection can be measured as a compression gap (CG). The compression gap represents the gap produced when an attempt is made to compress the pellet which has been rearranged due to the generation of a crack.

6. Capsule Reassembling Technology

In the recent JMTR, the demand for re-irradiation has increased. This calls for reinserting an already irradiated sample into the capsule in the hot lab, reassembling it, and then returning the sample to the reactor. This makes it possible to measure increases in the lifetime of the reactor, the enhanced performance of fuels and progress in research about high combustion.

In the JATR hot lab, the test fuel assembly, which has been water loop-irradiated, is disassembled within the cell. The fuel rod is subjected to a series of nondestructive tests, such as visual inspection, X-ray inspection, gamma scanning, dimensional measurement and the eddy current test. After the nondestructive tests are over, the fuel rod is encapsuled once again so that the irradiation experiment may be carried out. When assembling the capsule, various kinds of nondestructive tests are carried out within the cell, including measurements to determine the dimensions, straightness, and soundness of the fuel rods, together with leakage and pressure tests on the capsule itself.

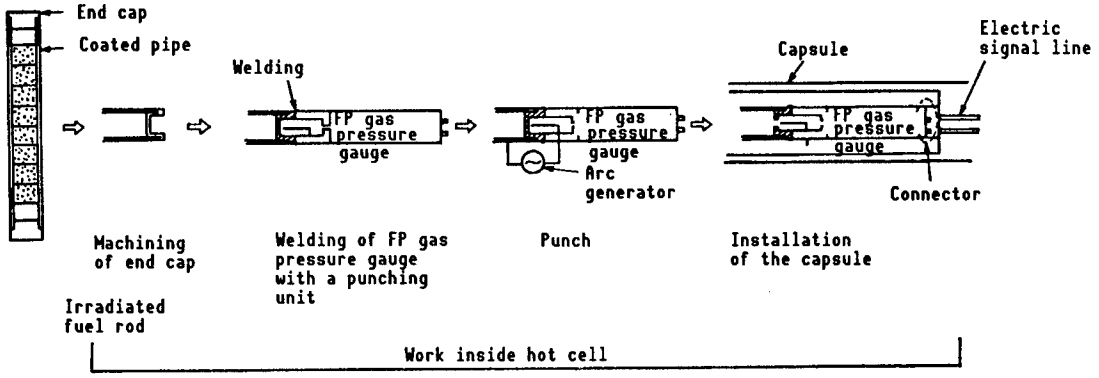

Figure 8. Installation of FP Gas Pressure Gauge in Irradited Fuel Rod

Furthermore, many attempts are being made to develop technology that will make it possible to install an FP gas pressure gauge to the end cap of the fuel rod in order to measure the internal pressure of the fuel rod during the re-irradiation test. Figure 8 shows the installation procedures. As illustrated in the figure, the end cap is accurately machined (±0.05 mm) to the required shape by a processing machine in the cell and the FP gas pressure gauge is welded to it. It is necessary to install a punching unit to the PF gauge before welding. When the gauge has been installed on the end cap, an electric current is passed through the electrodes of the punching unit and the end cap is partially arc-punched so that the space within the fuel rod can be connected to the internal part of the pressure gauge. The change in the internal pressure of the fuel rod can be measured more precisely by mounting the fuel rod thus assembled into the capsule and then irradiating the fuel rod once again. In order to do this, it is

necessary to carry out remote manipulations including the end cap work of the base-irradiated fuel rod, the punch welding of the PF pressure gauge with a punching unit, the welding of the end cap, inspection of the welds and installation of the fuel rod into the capsule in the hot lab facilities.

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20136/9365

FY88 S&T Budget Overview

43063032 Tokyo NIKKAN KOGYO SHIMBUN in Japanese 24, 25, 26, 31 May; 1, 8, 9, 14, 15, 23, 28, 29, 30 Jun; 6, 7, 12, 13, 14 Jul 88--FOR OFFICIAL USE ONLY

[24 May 88 p 5]

[Text] "Approach Run to 'A Science & Technology Power' based on FY88 S/T Budget"

There are three key phrases in the recent science and technology administration: "enrichment of creative basic research," "internationalization," and "promotion of science and technology in local areas." Amid political and economic environments suffering from trade friction externally, and an impoverished local economy due to concentration in the metropolitan areas internally, there is no way but up for the expectation for blessings from science and technology. In particular, the enrichment of basic research and internationalization are indispensable for an approach-run to become a great nation of science and technology. That kind of emphasis was clearly noticeable in the already approved FY88 budget for the promotion of science and technology. From among the science and technology-related budget of Y1,706.5 billion, new items will be discussed below for each ministry or agency.

National Institute for S/T Policy Established

Science and Technology Agency (STA)

In the STA's budget for its bureaus except working expenses for atomic energy, space, and the ocean, are the science and technology promotion coordination funds of Y9.2 billion to advance R&D projects carried out laterally among national research institutes. Among the new research topics listed in the funds are seven new topics, such as "research concerning the geological structure of ocean plate boundaries" to be tackled jointly with U.S. universities.

Two new systems were also approved: the fellowship system designed to invite younger researchers from overseas and the inter-ministerial basic research system to promote research based in a specified national experiment/research institute across ministerial boundaries. From the coordination funds each of the two systems will get Y300 million.

Three new topics were approved within the creative science and technology promotion system, which promotes original idea research. They are "the functions and structure of quantum," "picosecond chemistry," and "plant information substances" with the total budget of Y301 million. The research project teams will be formed in October 1988.

In the area of materials research, which is expected to carry the load of the new technological revolution, the R&D funds for new superconductive materials were appropriated for the first time. The appropriated amount is Y2.36 billion, and this will realize "the multicore superconductor research project" to be carried out by uniting research forces from industry, academe, and government.

As far as the promotion of science and technology at local levels, the local research exchange promotion project (the local high technology network project) will start in 1988. The project aims to promote personnel exchanges, information exchanges, and new technology development by setting up research information networks at the local level. The major objective of this project is especially to vitalize the local economy through the dissemination of research information via the network connecting local industries with the national experimental and research organizations of Tsukuba Research Academic Metropolis. Three model local areas will soon be selected.

The establishment of "The National Institute for Science and Technology Policy," which had been a long time wish of the STA, was also approved. The plan is to expand and reorganize the current National Institute of Resources to improve survey and data collection to strengthen the administration of science and technology.

Y3.25 Billion for Superconductivity

Agency of Industrial Science and Technology (AIST)

The FY88 total budget for AIST, MITI, is Y98,295 million, which is tight because of the reduction from FY87 by Y5,754 million. Within the budget the following five new programs will be carried out: (1) the organization of the industrial technology R&D promotion system, (2) the vigorous promotion of R&D of superconductivity technologies, (3) the promotion of research concerning the elucidation of biological functions, (4) the intensification of cooperation in international research, and (5) the promotion of domestic technological development.

For the organization of the R&D promotion system, large-scale, advanced research facilities, which are indispensable for the promotion of future R&D, will definitely be made available to a wide range of domestic and foreign researchers in an attempt to contribute internationally through R&D.

For this reason, "the New Energy General Development Organization" has been renamed "the New Energy and Industrial Technology General Development Organization." At the same time, the following new construction projects

have been added to commence in FY88: (1) the underground zero-gravity environment experiment center, (2) the technical research center for product use of the mining industry and marine biology, and (3) the ion engineering center. The working funds for the three facilities are Y4.7 billion. (The total working funds are Y19 billion.)

For the superconductivity technologies, R&D activities, from basic to applied, as well as international cooperation through cooperative research will be promoted. For this reason, the following projects will be carried out: (1) the elucidation of the superconductivity mechanism, the search for high temperature and ambient temperature superconductors, and the development of revolutionary fabrication technologies, (2) the development elements which use superconductive materials, and (3) the development of superconductive power application technologies. The budget is Y3.25 billion.

For the elucidation of biological functions, research expenses are subsidized for international cooperative research teams (consisting of Japanese and foreign researchers), which seek engineering uses and applications of biological functions by elucidating their mechanisms and exploring the possibilities of application to future industrial technologies. The subsidies are budgeted at Y170 million.

Experiment and research institutes under the jurisdiction of AIST, maintaining mutually close cooperation, will invite researchers from industry and academe within Japan and from overseas; or, researchers from AIST will be dispatched to experiment and research institutes to carry out research. The budget is Y250 million.

For international research cooperation, foreign researchers, mainly younger researchers (10 in number), will be invited to an experiment and research organization under AIST's jurisdiction for an extended period (one year) to do research and to study the Japanese language. The budget is Y54 million.

In the domestic technical development area, the following projects will be initiated: "superconductivity" by the next generation industrial key technology R&D system (superconductors and superconductive chips with a budget of Y1.6 billion); "production methods for highly functional chemicals (use of marine creatures)" by the large-scale project system (with total R&D expenses of approximately Y15 billion through FY96, Y20 million for FY88); an "endarterial laser surgery device" (with a budget of Y30 million) and a "three-dimensional view diagnostic system" (with a budget of Y34 million) both by the medical and welfare machinery and equipment technology R&D system.

[25 May 88 p 5]

[Text] Budget Increase for a Change

The Ministry of Agriculture, Forestry and Fisheries (MAFF)

Today, when the United States and other countries make strong demands for a free market for agricultural products, Japan's agriculture, forestry and fisheries need most to strengthen their competitiveness. For this reason, MAFF, setting the establishment of productive and stable agriculture, forestry and fisheries as the basic policy for the compilation of FY88 budget, came up with a positive budget of Y3,171.9 billion, a 4.7 percent increase over FY87, including related budgets (such as the industrial investment special account) under the jurisdiction of other ministries, such as the Prime Minister's Office. Since FY82, MAFF's budget has shown annual negative growth, so the budget increase after this long interval is expected to invigorate the administration of MAFF。

Productivity improvement depends solely on the development of pioneering technologies; therefore, the R&D budget was allocated on a priority basis. First of all, technology development research and basic leading research such as biotechnology, aimed at the 21st century (total budget of Y5,484 million) will be pursued aggressively. Specifically, research will begin on the following new topics: (1) the development of new agricultural, forestry, and fishery technologies by clarifying and controlling biological information; and (2) the development of a new production technology for fast-growing breeding cows for multiple birth production via in vitro insemination。

To expand the joint research through closer cooperation between industry, academe, and government, the government-private exchange cooperative research (Y53 million) will be carried out by mutual use of each other's research resources between the government and the private sector. "Tsukuba Agriculture and Forestry Research Exchange Center," which is to become the focal point for research and exchange, will be refurbished as a common facility for experiment and research organizations (Y290 million). Furthermore, the development and organization of the agriculture, forestry, and fisheries information system, which usesthe news media to keep abreast of the progress of the information-centered society, will be promoted (Y4.74 billion); the concept of informationalization of rural areas and the creation of information systems for various fields will be promoted, and the development of software will be started. In food industry, the food industry technology policy (Y960 million) will be expanded to promote the development of the high separation system (technologies of high enrichment and separation of food raw materials) and the development of new food materials.

In the fishery area, to deal with the greater restrictions of overseas fishing grounds due to the fixing of the200 nautical mile limit and to insure the maintenance and cultivation of marine resources and the appropriate use and control of fishing grounds in the seas surrounding

Japan fishing grounds within 200 nautical miles of Japan will be developed aggressively. For this reason, the new coastal fishery structure improvement project (total budget of Y100 billion from FY88 through FY93) will be inaugurated. Also planned is the intensification of the new technology development, such as the development of offshore fish farm systems, (Y1,046 million) to promote fishery development centering on "the fishery of producing and raising," and the improvement of policies for the cultivation industry (Y347 million), such as the organization of a guidance system to produce high-quality safe cultivated fish.

The resource cultivation control policy project (Y306 million) wil be carried out to promote the planned cultivation of coastal resources and the rational control of fisheries and to develop resource control by fishermen.

Environmental Survey of Tokyo Bay Area

Environment Agency

The total FY88 budget for the Environment Agency is Y46,836 million, which is Y472 million less than the FY87 budget. This year's priority items are (1) the preservation and proper use of environmental resources, (2) countermeasures for new contamination possibilities, (3) the promotion of anti-pollution policies, (4) the promotion of environmental policies from the international viewpoint, and (5) the strengthening of the base for administration of the environment.

Some of the major new research-related policies are discussed below. First, in the area of the preservation and proper use of environmental resources, a survey (budget of Y45 million) will be made of the Tokyo Bay area, where numerous large-scale development projects are planned and conceptualized, to preserve and examine the proper use of its environment. The evaluation of environmental effects, based on "The Working Outline for Evaluation of Environmental Effects," will be promoted properly and smoothly and the examination will be done for the realization of a prediction model concerning environmental effects, for which no prediction and evaluation methods have yet been established. (Y10 million)

For countermeasures for new contamination possibilities, responsible ministry and agency policies will be promoted (Y50 million) to deal with and develop comprehensive countermeasures for new environmental problems which are created by the progress of pioneering technologies and the expanded use of chemicals. The health hazard of chemicals from many atmospheric and aqueous media will be comprehensively evaluated, efficient control methods will be examined, and an information base concerning the control status and examples of contamination by various chemicals will be organized to formulate countermeasures for harmful chemicals. (Y19 million) Furthermore, a survey (Y5 million) will be conducted to understand the possibilities to influence the environment which has been influenced by pioneering technologies.

For the promotion of pollution prevention policies, the survey on automobile exhaust reduction countermeasures via new fuel (Y10 million) and the survey on predictions of overall effects of the countermeasures against nitrogen oxide (Y5 million) will be conducted to promote comprehensively the countermeasures against nitrogen oxide.

For the promotion of environment policies from the international standpoint, to deal with the problem of the reduced ozone layer in the stratosphere because of flon gas, a microquantity of gas such as flon gas will be observed and measured, and the research will be conducted at the National Institute for Pollution to elucidate the mechanism of ozone layer fluctuation and the ultraviolet ray's effects on the living body. (Y40 million)

To strengthen the base for administration of the environment, the research system at the National Institute for Pollution will be strengthened to carry out basic research concerning the fluctuation of the ozone layer in the stratosphere and its effects on the environment (Y35 million), and the empirical research concerning the evaluation of effects on the living body of atmospheric contaminants, consisting mainly of a particulate type (Y32 million); in addition, a method to predict the diffusion of, and to monitor environmental contaminants connected with the pioneering technological industries (Y120 million) will be developed by a national experiment and/or research organization.

[26 May 88 p 7]

[Text] Emphasis on Measures for Senile Aged

Ministry of Health and Welfare (MHW)

The FY88 budget for MHW is Y10,321.1 billion, which is 2.9 percent over the FY87 budget. The basic plan for the budget compilation is to prepare for the aging society of the future, in which healthy and fulfilled lives can be provided. For this reason, the science and technology promotion funds, to promote science and technology to establish disease prevention methods, have increased from FY87 to 8.1 percent to Y32.3 billion.

In 1987 MHW established its fundamental strategy for health and welfare science research. The key items of the strategy are: (1) the establishment of priority research fields and the promotion of research, (2) the reorganization of the research system and organization, and (3) the expansion of international exchanges. The FY88 budget executes a portion of the strategy.

In the priority research fields, pediatrics has been chosen, and a sum of Y150 million has been appropriated for pediatric research funds. For the clinical research on internal organ technology (research on artificial internal organs and organ transplant) a Y60 million budget has been allotted. For AIDS countermeasures which is a social issue, a sum of Y1,244 million has been budgeted. It will advance the establishment of

means to prevent an AIDS outbreak and a treatment method, the development of anti-AIDS drugs, and the establishment of an AIDS medical information center and an AIDS research center.

The senile aged people countermeasure funds are set at Y27.1 billion to deal with the increasing problem of senility among the aged. It is planned to do research to elucidate the cause for Alzheimer's disease, to promote measures to prevent outbreaks of the disease, and to organize treatment wards for patients. In addition, special blood measures to develop a vaccine for adult T-cell leukemia (Y64 million), and guidance on quality improvement of medicinal herbs aimed at the cultivation of medicinal herbs (Y5.01 million) will be promoted.

In the area of international cooperation, to contribute to the propagation of vaccine inoculation, a countermeasure against contagious diseases, the main cause of deaths in developing countries, R&D activities will begin on thermostable vaccines, specifically, thermostable BCG vaccine and DPT (mixture of three types) thermostable vaccine, which can be used in areas where the cold chain (refrigeration storage/transportation facilities) is not adequate.

Scientific Research Subsidies Up 8.4 Percent

Ministry of Education

Scientific research subsidies to promote original and pioneering research at universities have increased from FY87 to 8.4 percent to Y48,880 million. The subsidies are geared toward the intensification of "the priority domain research" such as natural science and material science, electronic and information science, and life science.

Accompanying the expansion of research organizations to cope with the progress in academic research, "The National Astronomical Observatory" will be inaugurated in July 1988. The Tokyo Astronomical Observatory and the Latitude Observatory, both at Tokyo University, will be reorganized and transferred, with the addition of a part of the Atmospheric Research Institute of Nagoya University, to create a new central organization for astronomic research. The outlay is Y1,650 million.

To intensify the nuclear fusion research at universities, the preparatory work will begin in 1988 for the establishment of "The Nuclear Fusion Research Institute" (tentative name). It will be established with the Plasma Research Institute of Nagoya University as the parent body and as a cooperative facility among national universities. Its construction site is expected to be Toki City, Gifu Prefecture.

For the organization of research bases, it is planned to start building an international network at the Academic Information Center in Otsuka District, Bunkyo-ku, Tokyo. With the U.S. National Science Foundation as a partner, it is expected to dissolve "the criticism against inaccessibility" concerning academic information. The number of national information

management centers will increase from the previous 39 universities to 46 universities. To dissolve science and technology friction, the establishment of "the special foreign researcher system" has been hurriedly decided. This is equivalent to the exchange program of the Science and Technology Promotion Coordination Fund of the Science and Technology Agency; the number of researchers to be accepted is similarly set at 100. The targets are young researchers with recent doctorates from the United States, the United Kingdom, West Germany, or France. The research term is one year. Each researcher will receive living expenses of Y320,000 per month from Japan Society for the Promotion of Science.

"The cooperative research centers," to promote exchanges between industry and academe, will be established at five universities: the Muroran Institute of Technology, Gumma University, Tokyo University of Agriculture & Technology, Gifu University, and Nagoya University. The centers will offer space for joint research and/or contract research as well as promote support for technical education by private industry. The main aim is the promotion of science and technology at the local level.

Five New Projects

Ministry of Labor

There are two research organizations under the jurisdiction of the Ministry of Labor, namely, the Industrial Safety Institute and the National Institute of Industrial Health. The Industrial Safety Institute lists three new FY88 research topics. The first topic is "research concerning the prevention of the collapses of cranes due to parts damaged by aging."

The number of crane disaster cases has been increasing since 1981. For this reason, it is planned, as a 3-year program through FY90, to prevent further crane disasters caused by damage from aging by updating repair methods for the crane's structural materials and establishing a life prediction method after each repair. The FY88 budget is Y22 million.

The second topic is "research concerning the reduction of the noise of small-size machines for construction (concrete cutter)." The reduction of noise created by the concrete cutter will be pursued by improving the cutter disc, developing a new muffling mechanism, and improving the structure to reduce the vibration of the cutter frame. This is a 3-year program with an FY88 budget of Y11 million.

The third topic is "research concerning the prevention of scattering, by static electricity, of particulate substances into the environment," to prevent the scattering of combustible mist or dust created by manufacturing processes, at the source of occurrence, as well as to develop an environment cleaning system to recycle the substances back to the source of occurrence. This is a 3-year program with an FY88 budget of Y11 million.

The National Institute of Industrial Health lists two topics: "research concerning the toxicity evaluation for chlorinated hydrocarbon solvents" and "research concerning the evaluation of biological effects of environmental contaminants by the use of human peripheral hemolymphocytes." A large amount of chlorinated hydrocarbon solvents, such as trichlorethylene, is being used for defatting operations, in the dry cleaning process, and in the semiconductor industry. These solvents are relatively less toxic but are similar in structure to strongly toxic carbon tetrachloride. Although every operator who handles any of the solvents is required to have his liver functions tested, the blood transaminase value previously used in the test is not necessarily an effective toxicity index. Hence, the chlorinated hydrocarbon solvent research to establish a new toxicity evaluation method.

The research with human peripheral hemolymphocytes seeks indices and the development of a simple evaluation method for the direct effects of environmental contaminants on humans. The research term for both topics is 3 years. The FY88 budgets are Y12 million and Y9 million, respectively.

[31 May 88 p 5]

[Text] Embark on Multipurpose Satellite System

Ministry of Transport

The FY88 science and technology-related budget for the Ministry of Transport is Y12.46 billion, down 2.3 percent from the FY87 budget.

Of this amount, Y7.153 billion is the expenses for five research organizations: the Ship Research Institute, the Electronic Navigation Research Institute, the Port and Harbor Research Institute, the Traffic Safety and Nuisance Research Institute, and the Meteorological Research Institute. The expenses for the administrative segments of transport technology R&D and the static meteorological satellite business of the Meteorological Agency are budgeted for Y5.308 billion.

There are 51 topics in the specified research, of which 16 are new in 1988. The major topic is "survey research for the development of a transport-related multi-purpose satellite system," which starts in 1988 with the budget of Y17 million and is expected to run for 5 years at a total cost of Y106 million. The project aims at the use of a man-made satellite in manyfields of general transport such as meteorological and marine climate observation, navigation assistance and rescue operations for aircraft and ships, and mobile communications systems. Including next FY, the budget is Y124 million.

The project for "survey analysis of problems of sudden start by AT vehicles" is budgeted for Y39 million to clarify the cause(s) for the sudden starts and sudden accelerations by vehicles with automatic shifts, which is becoming a social issue. For 3 years starting in 1988 the project for

"research concerning the air-ground data link using radar" will be carried out with a total budget of Y68 million to try to improve the reliability of communications in aviation control.

In the ship technology field, by using the improved processing capability of the computer, "research concerning the development of new ship models and safety evaluation technology through the introduction of a sophisticated numerical analysis method" will be started with the FY88 budget of Y17 million and the total budget of Y106 million for the next 5 years.

Research in the atomic power-related field will pursue "the technology for the mechano-destructive evaluation of the structural elements of a nuclear reactor," "porous ceramic barrier materials," "evaluation, by laser supersonic waves, of the reliability of structural materials of a nuclear reactor," and "research concerning how to make intelligent man-machine interfaces in an atomic power plant."

Additionally, in the pollution prevention and energy conservation fields, "research concerning the transport of acid rain-related contaminants in the East Asian area" will begin in 1988.

Frontier Technologies

Ministry of Posts and Telecommunications

The centerpiece in the FY88 science and technology-related budget of the Ministry of Posts and Telecommunications is "R&D for telecommunications frontier technologies." The FY88 budget of Y153 million was approved for the project. Other major topics include "research on the satellite combining broadcasting and communications" with a budget of Y130 million and "R&D for the space weather forecast system" with Y14 million.

In April 1988 the Radio Research Laboratory was renamed the General Laboratory of Communications, which in turn selected "five research fields aimed at the 21st century." Within the framework ofthe research fields, the new topics are introduced below. First, in the field of the highly functional intelligent communications, "R&D on the key technology for the multidimensional plastic network," one of the topics for the telecommunication frontier technologies; "development of the cylindrical scanning formula" for the research on the antenna-vicinity measuring system; and "basic research on the high quality digital voice broadcast" will be pursued.

In the field of human and biological information, "R&D of the superhigh efficiency symbolization technology with a brain functions' model," as a part of the frontier technologies, and "basic research concerning the electromagnetic response of plants" are the new topics. In the field of communications in the manned space era, there are "the combination satellite" and "research on the technology of an efficient system to use satellites." In the field of earth-planet system environment, "the space

weather forecast" and "research on the two-wavelength Doppler radar for rainfall observation from space" are new. Finally, in the field of electromagnetic wave/materials, the project on "R&D of the superhigh speed, high efficiency communication technology using high temperature superconductors," a frontier technology topic, will start.

Two Topics in Construction Projects

Ministry of Construction

The FY88 construction technology R&D-related budget of the Ministry of Construction is Y5,416 million, a 0.5 percent increase from the FY87.

New topics for the construction technology R&D expenditure (the comprehensive technical development project), which occupies a large portion of the entire budget, are "development of technologies to use newly developed materials for the construction industry" and "development of the technology to convert reinforced concrete buildings into super lightweight and super high rise buildings." Each has a 5 year R&D term.

Recently the development and applications ofnew raw materials, such as compound materials, new metallic materials, and fine ceramics, have flourished. The purpose of the above project "new materials for the construction industry" is to improve drastically construction technology by effectively using these new materials in the construction field. The appropriation for the project in FY88 is Y60 million.

The project for "reinforced concrete buildings" aims to realize a drastic increase in the strengths of structural materials and a decrease in the weight of the structural framework by the use of high strength and high quality materials, and, in turn, to meet the needs for higher elevation and enlargement of buildings. Furthermore, the development of the design and construction technologies for new reinforced concrete buildings which can be constructed under inferior site conditions will be pursued. The budget is Y32 million.

New topics under the government-private sectorcooperative research are "development of a control system for excavation of small-diameter conduits" and "development of a technology to apply the satellite survey system to the construction industry." The former is to develop a system using AI (artificial intelligence) technology to organize life line facilities (telephone, power, water, and sewer lines) in urban areas.

The latter aims to develop a construction survey system using the GPS (the global projection system), which, with the aid of man-made satellites will be free of such problems as visual obstacles and error accumulation, and will be able to conduct efficiently and accurately the survey for a large-scale construction job. Each of the new topics is a 3-year project.

[1 Jun 88 p 5]

[Text] Nuclear Fusion Gets Y23.35 Billion

Japan Atomic Energy Research Institute (JAERI)

The FY88 total budget for JAERI is Y106,589 million, which is 1.8 percent, or Y1,938 million, less than the FY87 budget.

The nuclear fusion research shows the largest appropriation, Y23.35 billion. Within that program, attempts will be made to use larger current and to develop and organize a sophisticated instrumentation device for the critical plasma test equipment "JT-60"; experiments will be started to improve its capability with the addition of new functions such as the underside diverter, pellet injection, and high efficiency current drive. For R&D of nuclear fusion reactors, the concept of the next generation large-scale devices will be examined and the reinforcement of JFT-2M (interim data value torus device) will be initiated. Also, the demonstration toroidal coil project and the large-scale toroidal coil project will start. In the research of fuels and materials for the nuclear fusion reactor, hot tests will be carried out in the tritium process research building along with the research on handling technology and production technology for tritium.

The appropriation for the engineering safety research segment is Y99.2 billion, which is 18 percent more than the FY87 budget. The construction of the new building to house the fuel cycle safety engineering research facility will be initiated (Y3.82 billion). This is to promote R&D concerning the safety of nuclear fuel facilities to establish the nuclear fuel cycle. In the area of engineering safety research, reactivity initiated accidents, fuel safety, and accidents due to the loss of coolant will also be investigated.

In the high temperature engineering test research segment (Y4.22 billion), the scale design of the reactor housing and the structural materials for reactor's interior will begin, aiming for an FY89 start of the construction of a pilot reactor. In addition, it is expected to promote mock reactor core experiments using a critical experimental device with a high temperature gas reactor.

In the nuclear ship "Mutsu"-related segment (Y7.31 billion), the incidental land facilities of the newly designated mooring port of Sekinehama will be constructed with expected completion by the end of FY88. Various tests, inspections and maintenance, and the training of a crew will be conducted. The development of the nuclear ship engineering simulator is also planned.

In the general research segment (Y30.23 billion), the reconstruction of the pilot reactor JRR-3 and the construction of the storage facility for low and medium level solid wastes will begin. Also, the development of the technology to decommission the nuclear reactor will be pursued by doing decommissioning tests of the "JPDR" facility, a power test reactor.

In the international cooperation segment, a system is planned for the acceptance of foreign researchers by the construction of a research exchange facility, and personnel exchange, training, and information exchange will be emphasized.

Laser Enrichment to Start

Power Reactor and Nuclear Fuel Development Corporation (PNC)

The FY88 total budget for the PNC is Y221.208 billion, which is down Y12.718 billion, or 5.4 percent, from the FY87 budget.

One half of the budget, Y115.915 billion, is for the development of a new model power reactor. The largest item within that budget is Y68.945 billion for the fast breeder reactor "Monju," which is under construction with the aim of reaching its critical point in FY92. In FY88 construction will continue for site development, unloading quay, nuclear reactor building, and turbine building; the construction of machinery and the installation of the reactor vessel will also be done.

In the development of a new model conversion reactor, research will be carried out by irradiation tests which are necessary to improve the plutonium fuel for the demonstration reactor. To be continued from FY87 are the development of plutonium fuel for the final confirmation of the comprehensive functions of the technical development facility for the manufacture of high speed breeder fuel (Y4.99 billion), the development of TRU (transuranium element) waste treatment technology using the plutonium waste treatment development facility (Y1.48 billion), the development of plutonium conversion technology (Y2.78 billion), and development of the processing technology for plutonium fuel (Y1.46 billion).

The budget for the development of the recycle technology for spent fuel is Y54.461 billion. Of that amount, the waste treatment technology development expenditures (Y3.61 billion) doubled from FY87. For the waste treatment facilities (Y3.61 billion), the geological survey is planned to continue for the strata selected in the first stage, and the real scale in-situ tests concerning man-made barriers, the development of survey machines and equipment required for the geological and enivronmental survey, and the development of a waste treatment system will begin.

In the development of the reprocessing technology for high speed reactor fuel (Y3.8 billion), the detail design of a hot engineering test facility for high speed reactor fuel reprocessing will be initiated. Simultaneously, to advance effectively the development of machinery, cooperative research is planned with the United States. In the development of treatment and storage technologies for high level wastes (Y5.49 billion), the development of solidification treatment technology, the construction of a glass solidification plant, and the development of storage technology will be pursued.

In the development of nuclear fuels (Y25.47 billion), the development of laser enrichment technology (Y860 million) is to start. Considering the success of the Institute for Physical and Chemical Research (PCR) on the demonstration tests for the principle of the molecular method, the development of key technologies and the design and production of system devices will be done in cooperation with the IPCR. As for the uranium enrichment prototype plant, its No 1 operational unit (with the separation capability of 100 ton SWU per year) just started to operate on 26 April 1988, and its No 2 operational unit (with the separation capability of 100 ton SWU per year) will be completed in the middle of FY88; the first test operation of the plant is expected to commence early in 1989.

[8 Jun 88 p 6]

[Text] Significant Increase of Nearly 10 Percent

Institute for Physical and Chemical Research (IPCR)

The FY88 total budget for PCR is Y17.389 billion, up 9.8 percent as compared to the FY87 budget. This shows an almost 10 percent increase when many research organizations' budgets have either stayed flat or decreased. This is because the IPCR holds many new research projects which commence in FY88.

New research projects include research on critical zone laser chemistry (Y16 million), research on new biological control science (Y31 million), research on new superconductors (Y124 million), manufacture of isotope-selective silicon films (Y3.7 million), and research on thought function (Y160 million).

The research on critical zone laser chemistry is the study of laser's reactions at the boundaries between solid and gas and between liquid and gas phases. This research is to last for 3 years through FY90. In FY88, the research is planned for the intermediate zone between solid and gas phases.

The research on new biological control science aims to elucidate the control mechanisms and establish new control technologies against living organisms by searching for and cloning substances which control, at the molecular, cell, and organism levels, the growth, proliferation and differentiation of living organisms from microbials through animals and plants.

In FY88 the main activities will be research concerning the molecular design for new biological control substances and research concerning the development of biological control technologies at the molecular level.

In the new superconductor research, the analysis and control of various properties of materials and the film-forming and micronization of new superconducting materials will be pursued. For the development of isotope-selective silicon films, the objectives are to produce such films from disilane hexafluoride by the carbon dioxide laser infrared multi-photon dissociation method, and to develop technologies for separation, enrichment, and film-forming.

The research concerning thought function will be done as a part of the international frontier research system, which embraces two other projects, research on biological homeostasis and research on frontier materials. The thought function research will be pursued by three teams: the thought electric current team, the thought network team, and the algorithm team. They will analyze changes in neural current in the brain accompanying thought activities, analyze the structure and interrelationship of nerve cells in the brain's basic unit, and build a model of the cerebral neural circuit to elucidate the basic principles of thought function in the brain.

In the biological homeostasis research, research activities are continuing on the animal's aging process and the hereditary and material control of plants' homeostasis, with a focus on the function (homeostasis) of advanced organisms to maintain the total balance without ever losing normal conditions by controlling their own physiological functions. The frontier material research will target proteinaceous materials, which make up the molecules, microunits of substances, and organisms, and try to elucidate the relationship between unknown functions and structures, which are expected to emerge through the control, at a molecular or finer level, of the minute structure of materials.

Radiation research which started in FY87 will initiate concrete research on electromagnet and high frequency devices. Therefore, the FY88 research expense shows a significant increase from FY87's Y65 million to the current Y430 million. Also, the gene composition research expenditures have increased from FY87's Y64 million to the current Y207 million because of the new project to develop equipment with an improved capability to analyze genes.

Elsewhere, solar ray energy science research, heavy ion science comprehensive research, and uranium enrichment laser research will be conducted. Carry-over projects from FY87, such as the construction ofthe accelerator for heavy ion science and the ring cyclotron building, will be continued.

Cancer Treatment Equipment Production to Start

National Institute of Radiological Sciences (NIRS)

Like the IPCR budget, the FY88 budget for NIRS increased significantly, i.e., by 14.6 percent, from FY87 to Y8,118 million. This is because the full-scale production of the heavy particle beam cancer treatment equipment will be initiated.

The equipment is built as a part of the 10-year comprehensive anti-cancer strategy at a cost of Y36 billion. The survey research and the equipment design were already completed, and the production of a portion of the equipment started in the end of FY87. The FY88 budget (Y1,721 million) for the heavy particle beam cancer treatment equipment is up 10.6 percent as compared to the FY87's budget. In FY88 the production of synchrotron, the main accelerator, will begin. Also, the building construction will

start. The equipment will be completed by the end of 1993, the irradiation of living organisms will start with mice in January 1994, and the clinical trials are scheduled to begin in FY94.

This equipment is designed to destroy directly cancer cells by precision irradiation of cancer with heavy particles of carbon, neon, and silicon after acceleration by the accelerator. Although currently used X-rays and gamma-rays lose intensity as they move into deep parts of the body, the heavy particle beam, on the contrary, peaks at a depth; hence the capability of the precision irradiation on cancer cells without destroying surrounding healthy cells.

The radiological special research expenditures are Y297 million with which basic research in medicine, biology, and environment will be conducted as a carry-over from FY87. Also, the cyclotron facility will continue to be equipped.

[9 Jun 88 p 8]

[Text] Core Organization Designate for Superconductor Project

National Research Institute for Metals (NRIM)

The budget for NRIM is Y5,174 million, up 14.6 percent from FY87. The reason is that NRIM has been designated as the central core research organization by the Science and Technology Agency for its new "multicore superconductive material research project," which starts in FY88, and is scheduled to initiate R&D activities on new superconductive materials. This superconductivity research takes up 20 percent of the total budget, or Y1,088 million.

The multicore project on superconductivity is pursued jointly by government, industry, and academe, by organizing research cores. There are 15 cores in this project, six of which are the responsibility of NRIM; in FY88 three cores will be started.

The theory core (Y5 million) will pursue research on the analysis of the electronic structure of superconductive materials, the construction of theoretical models with respect to the superconductivity mechanism, and the deduction of superconductive properties, to find their unique characteristics.

The film core (Y188 million) will try to establish the technology to produce superconductive films by low-temperature precision synthesis to use them commercially for the substrate material of Josephson elements and super LSIs.

The superconductive efficiency evaluation core (Y814 million) will develop an 80 tesla-class long-pulse magnet, a 40 tesla-class hybrid magnet, a 20 tesla-class large diameter superconductive magnet, and a magnetic

property measuring device in a super-precision magnetic field, to evaluate from many angles the characteristics of superconductors. Only preliminary research will be done for the database core, raw material control core, and complex fabrication core.

The special research project (Y153 million) will also have the following carry-over topics from FY87: the development of intermetallic compounds for high function luminous chips, the basic research on a non-contact material evaluation method with a laser beam, the R&D on machine and equipment materials to be used at superlow temperatures, and the development of lightweight thermostable intermetallic compounds.

Investment of Y400 Million for Superconductors

National Institute for Research in Inorganic Materials (NIRIM)

The total budget for NIRIM is Y2.26 billion, an increase of Y180 million from the FY87 budget. The main reason for the increase is the test research expense of Y1.07 billion, an increase of Y520 million from FY87. Of the expenditure, Y389 million will be invested in R&D of superconductive materials (multicore superconductive material research project), which started in FY88.

For the project, three research groups will work on the following: the new material search core (Y90 million) to seek new composition and/or new structure materials by using various synthetic methods, the single crystal growth core (Y28 million) to grow large single crystals to compile basic data for the development of new superconductors, and the crystalline structure analysis core (Y270 million) to obtain information necessary for the elucidation of superconductivity mechanism and the development of superconductive materials by analyzing the structure of superconductive substances. Each of these core activities areto continue from FY88 through FY92.

Three new groups are to be organized within NIRIM to start to work on three new topics for its group research (working research). They are: (1) research on bismuth-base oxyfluorides, which are drawing attention as excellent electric conductors, such as an ionic conductor and a superconductor (Researcher-in-charge: Mr Shigeo Horiuchi), (2) research on copper perovskite, the most popular high temperature oxide superconductor (Researcher-in-charge: Mr Toshi Okai), and (3) research concerning the use of rare earth metals garnet as the garnet used in laser medium crystals, magneto-optical chips, and electron beam detection chips (Researcher-in charge: Mr Shigeyuki Kimura).

In addition, full-scale research will start soon in the zero-vibration special experiment building (to be completed by the end of March 1988) designed for material analyses at micron level.

Elucidation of "Water & Disasters"

National Research Center for Disaster Prevention (NRCDP)

The topic for NRCDP is multi-faceted attacks on natural disasters. In FY88 special research concerning the causative mechanism and evaluation of the effects of weather disasters will be initiated. In Japan, citizens' lives are most seriously affected by water-related disasters, such as concentrated heavy rainfalls, heavy snowfalls, floods, and tidal waves. Eighty percent of the deaths and 70 percent of theproperty losses caused by natural diasters are caused by water.

This research aims to clarify the causative mechanisms and social and economic effects of weather disasters by understanding "the action of water." In Natori District of Miyagi Prefecture, which in 1986 suffered from concentrated heavy rainfall, and in the northern Kanto District, which is likely to be affected by drought, research on the effects of flood and drought on farm fields, respectively, and on the causative mechanisms will be carried out. The first FY budget is Y15 million.

In the earthquake prediction-related area, the 2,000 meter-class shaft boring will be started for earthquake survey near Ashio Mine in Tochigi Prefecture. This area is noted for the group occurrence of earthquakes in shallow strata. Core samples will be collected by boring from areas of destroyed base rock to understand, in progress, the phenomena in the underground area around an earthquake epicenter. It is planned to dig to a depth of approximately 500 meters in FY88. The budget is Y100 million.

In connection with the prediction of ocean trench gigantic earthquakes, an aerial infrared imaging device will be developed exclusively for volcanoes. It is expected to be able to measure up to 1,500°C and to be effective in catching the movement of magma. Also, the device will have another feature, the side-looking method to allow observations from the side of a volcano, and simultaneously improve the safety of observation operations. The budget is approximately Y100 million, including the software development expense.

In the snowfall countermeasure area, a Doppler radar device will be used full-scale to explain the mechanism of ground blizzards which occur on level ground. This is the third of such radar devices in Japan, with the other two located at the Meteorological Research Institute of the Ministry of Transport and at Hokkaido University. Cooperative research among the three organizations is also planned.

[14 Jun 88 p 5]

[Text] ADEOS Development Among Three New Topics

National Space Development Agency (NASDA)

The FY88 total budget for NASDA is Y113,645.7 million. This is less than FY87 by Y1,291.3 million mainly because of private funding and operations income of Y17,111.7 million is down Y5,177.3 million from FY87, even though the government funding and subsidies have gone up by Y3,886 million to Y96,534 million.

The following three new topics are included in the budget: (1) R&D on the platform technology earth observation satellite (ADEOS), (2) development of the geostationary meterological satellite No 5 (GMS-5), and (3) development of space experiment devices to participate in the first international micro-gravity laboratory program (IML-1).

In the ADEOS project, the purpose of the satellite is to maintain and expand earth observation technology, carry out technology development necessary for the future development of a platform-type satellite and to relay earth observation data, and to promote international cooperation in the field of earth observation. The launching of an H-II rocket is scheduled in FY93; the preliminary design of the rocket will also begin.

The satellite, GMS-5, will be launched in FY93 by an identical rocket into a geostationary orbit, and its development work will begin in FY88. Because the IML-1 project aims to compile space environment use technologies necessary for experiments to be done in space stations, the immediate work is to develop space experiment devices to carry out material testing when Japan participates in the U.S. program in FY90.

In addition, development work will begin for the proto-flight models of the earth resource satellite No 1 (ERS-1), which will be launched in FY91 by the H-I rocket mainly to search resources, and the engineering test satellite VI-type (ETS-VI) to be launched in FY92, to confirm the capabilities of the H-II rocket.

Work on Compound Material Test Facility

National Aerospace Laboratory (NAL)

The FY88 total budget for NAL of the Science and Technology Agency is Y10,110 million, down Y157 million from FY87. The research objectives are (1) STOL craft, (2) revolutionary elemental technologies for aerospace transport, (3) numerical simulation technology, and (4) applications of aviation technologies in other fields; additionally, work is planned to (5) improve the transonic wind tunnel, and (6) provide compound material structure testing facilities, as necessary for the R&D of aviation technologies.

The only new topic is the provision of compound material structure testing facilities. Advanced compound materials are indispensable for revolutionary progress in aviation and space structures, such as the conversion to super-lightweight structures, the creation of thermostability, and the control of functionalization and thermal expansion. Although some other nations already have such facilities, Japan has none to test the structure of compound materials. Therefore, the following projects are planned: a facility to test material strength under requisite environmental conditions, to gather data necessary for the speedy selection of optimal part materials; an environmental part structure strength test facility to test strengths of key parts of the fuselage under high and low temperature environments; and a non-destructive inspection facility to improve the reliability of compound material structures. The budget is Y374 million.

Also, for the STOL craft project, flight tests will continue with the test craft "Asuka" and full-scale experiments on take-off and landing in the STOL mode will be made to confirm new technologies. International cooperative research will be promoted with the Ames Laboratory of NASA (the U.S. National Aerospace Agency) concerning the examination of design standards for the STOL craft. For the revolutionary aerospace transport elemental technology project, the space shuttle transport system technology (the clarification of system concept) will be undertaken.

Basic Design Begins for "Dolphin 10K"

Japan Marine Science and Technology Center (JAMSTEC)

The FY88 total budget for JAMSTEC is Y10,371 million, up Y1,757 million from FY87. Five major projects are planned: (1) the deep-sea submersible exploration ship, (2) underwater operation technology, (3) marine utilization technology, (4) R&D on marine observation technologies, and (5) local cooperative R&D projects. The key project is the deep-sea exploration ship; the construction of a 6,000 meter class underwater exploration ship, "Shinkai 6500," which began in FY87, will continue full-scale with the completion target of FY89. The budget is Y3,777 million.

The basic design of a rescue and prior survey device will be initiated. The budget is Y41 million. The device is "Dolphin 10K" (tentative name; a 10,000 meter class unmanned surveyor), the successor of "Dolphin 3K" (a 3,000 meter class unmanned surveyor), which is scheduled to go aboard "Yokosuka," currently under construction (budgeted for Y1,270 million) as the supporting mother ship for "Shinkai 6500."

In the marine observation technology project, in an attempt to use efficiently the Japan Current, which significantly influences Japan's weather, marine conditions, and marine industries, automatic observation will be made on atmospheric and marine conditions in the sea area at 20° N. Latitude from the meteorological observation tower built on Okinotorishima. The budget is Y39 million.

As a part of the Aquamarine Program, the local cooperative R&D project will support local governments in promoting their own marine development projects by sharing equally the expenses with local governments. The budget is Y50 million.

[15 Jun 88 p 5]

[Text] Four Special Projects Start

National Research Laboratory of Metrology (NRLM)

The FY88 total budget for NRLM is Y1,965 million, down from FY87's Y2,057 million. NRLM will start four special research projects and participate in projects related to the key technologies for the next generation industries and the human frontier program.

One of the special research projects is research concerning humidity sensor capability evaluation technology (Y8.4 million through FY90) to establish a capability evaluation method for humidity sensors, which, due to manufacturers, have non-standard markings, as well as to develop a calibration method for dew point graduation to be used in low temperature regions, but which is not yet standardized.

The research project to establish and evaluate the capability of laser cooling technology (Y15 million through FY91) will try to produce super-low temperature ions and atoms by using laser cooling of atoms.

The research project on a mass-indication method by superconductive magnetic levitation (Y15 million through FY92) aims to define new mass systems to replace the international kilogram prototype, and the instrumentation technology research project for high pressure gas flux (Y16 million through FY92) will develop a flow meter, which, after calibration under ambient atmospheric pressure, can perform measurements of conditions under pressure.

In addition, the technical development project for medium and small enterprises will promote research on surface finishing methods and evaluation methods for machine parts (Y8 million through 1990). The project for the peaceful use of atomic power technology will promote research on the refinement of instrumentation technologies for high temperature thermal characteristics (Y10 million through FY92). The energy conservation project will promote research on thermodynamic characteristics instrumentation technologies, which are indispensable for the development of superconductive wire materials (Y9 million through FY95).

The new generation superconductivity project will pursue the development of precision instrumentation technology which is indispensable for the elucidation of superconductivity (Y10 million through FY98). In connection with the human frontier program, the three-dimensional acoustic measurement of cells will be studied (Y6 million through FY90).

Development of Low-Pollution Studded Tires

Mechanical Engineering Laboratory (MEL)

The FY88 total budget for MEL is Y3,170 million, down from FY87's Y3,220 million, but seven new special research and 27 new working research projects will be initiated.

Among the special research projects, the research project on the safety technology for large-size coupled vehicles (Y7.9 million through FY92) aims at the development of the operation technology for unmanned coupled vehicles and the measurement principles for coupled vehicles, which move in three dimensions, i.e., up and down, left and right, and forward and backward. In the extreme environment tribology research project (Y8 million through FY92), a method to evaluate high precision drive technology in an extreme, that is, highly corrosive or super clean, environment, and the selection of new materials for use in highly durable sleeve materials will be studied.

Through the research project on space environment will seek mechanical control technology aiming at the high precision attitude control technology necessary for satellites and space bases (Y8.1 million through FY92), and operation methods for equipment which has been transported to other distant heavenly bodies. A research project (Y19.26 million through FY91) is also planned for studded tires which have become a social problem. The development guidelines will be sought for minimum-stud (spike) tires, which displays the spike effect only on easy-to-melt ice of 0°C to -5°C and does not display the effect under other conditions. The research project to develop technology to prevent solid-transmitted sound (Y19 million through FY91) aims at the clarification of the mechanism of noise or transmitted sound caused by vibration and theimprovement of indoor sound insulation of rooms in residences and other buildings. It seeks to establish means to control secondary sound sources such as wall and floor virbrations.

In the research project on advanced fabrication and evaluation technologies for durable part materials for atomic energy (Y15 million through FY92), special projects will be carried out to improve durable atomic energy parts materials which are used in a light water reactor, to a maintenance-free level, and to develop technologies to fabricate durable part materials by means of electric explosion fabrication equipment.

In the area of major projects, the evaluation of fabrication technology for electric generation facility parts materials will be initiated (Y12.8 million) within the R&D project on super-pioneering fabrication systems. Mechanical characteristics will be examined with a supersonic microscope or an optical acoustic microscope.

In R&D for medical and welfare devices and technologies, the development by FY91 of a diagnostic stereo-imaging system to view MRI images in three dimensions using holography will be pursued (Y5 million) as a part of the diagnostic holographic stereo-imaging system project.

As a participant in the human frontier science program project, the control of human sense and motion will be studied to elucidate the control mechanism motivated by human sense information (Y9.6 million). The chemical information transmission factors will be studied to clarify the brain's mechanism for generating information about the senses, recognition, and motion, through chemical information transmission (Y9.6 million); and the kinetic functions of biological molecular aggregates will be studied to elucidate efficient kinetic functions of the living body at the molecular level (Y7.6 million).

Additionally, as a new international research cooperation project, the measurements and non-destructive inspection of three-dimensional objects will be studied jointly with Indonesia. Twenty seven of 78 working research projects are new in FY88.

[23 Jun 88 p 5]

[Text] National Chemical Laboratory for Industry

New Synthesis Technology for Organic Silicon Compounds

The FY88 total budget for the National Chemical Laboratory for Industry is Y3.68 billion, which is an increase of 0.8 percent from FY87's Y3.65 billion. The nucleus of new research projects will be four projects in the special research outlay, e.g. "Research concerning the creation of organic silicon materials." In addition, the budget includes "Research concerning advanced superconductive materials," which is a Moonlight Program, and "Research of Superconductive materials and superconductive chips," which has been designated as a next generation project.

The subjects and descriptions of the four projects in the special research outlay follow. The first is "Research concerning the creation of organic silicon materials" (budgeted for Y14 million through FY90), which aims at the creation of new synthesis technology for organic silicon compounds, which have promise as electric conductors and heat resistant materials. The organic silicon compound might be capable of creating another industry similar to the organic chemical industry created by the raw material, petroleum. This research project is a challenge to that possibility.

The project, "Research on synthesis and application of organic super-thin films" (budget of Y13 million through FY90), aims to produce super-thin films of fluorine-containing polymeric compounds, which are drawing attention in the development of new materials, and to develop new functional super-thin films in combination with molecular arrangement control.

The project, "Research on synthesis of physiologically active organometallic compounds" (budget of Y11 million through FY91), will be for the development of functional substances which have medicinal actions and affinity to new physiologically active organometallic compounds. Finally, the project, "Research concerning methods to monitor components of atmospheric floating microparticles" (budgeted for Y23 million through FY91) aims at the development of an optical acoustic analyzer, which can catch the components of atmospheric microparticles while floating in air, and a floating microparticle counter.

On the other hand, the Moonlight Program, "Research on advanced superconductive materials" (budgeted for Y11 million), aims to synthesize a wire-coating superconductive ceramic film material using the thermal coating decomposition method. Also, the next generation "R&D of superconductors and superconductive chips" project (budget of Y37 million) will explore new superconductive materials with the main focus on chalcogenide, a multi-element In the Human Frontier-related category, the project of "Research on the manifestation of genetic information and the morphological formation functions" (budget: Y11 million) is planned to isolate proteins using yeast genes and to clarify their properties; in the project "Research on molecular recognition and response functions" (budgeted for Y14 million) a study will be conducted of the structure of biological materials from which it is difficult to make single crystals.

In the ordinary research outlay, 26 new research projects will start, including "Surface analysis by STH and the improvement of surface analysis precision" and "Synthesis of conductive polymers using solid phase polymerization under super-high pressure." Together with ongoing projects, there will be 76 projects.

Fermentation Research Institute

Microbial Odor Removal

The FY88 budget for the Fermentation Research Institute is Y1.07 billion, Y13 million less than that for FY87.

The backbone of its research program is the special research outlay where three projects, including "The development of gene manipulation technology for plant cells," will be tackled. In the Human Frontier Program, four projects are planned. There are 16 projects in the current research outlay, of which six are new, including "Unusual metabolism by microorganisms," "The structure and analysis of functional molecular aggregates," and "Basic research on proteins with control functions."

The following are among the new projects in the special research outlay. The project "Development of gene manipulation technology for plant cells" (budget of Y7.35 million through FY91) will explore the gene manipulation technology for plant cells, such as the creation of plant emergence vectors by isolating DNA (deoxyribonucleic acid) related to the emergence control of plant genes. The project "Development of an efficient microbial

deodorization method" (budget of Y11.8 million through FY91) will tackle the development of an economic deodorization method through the search for, and the isolation of microorganisms which oxidize and decompose odorous substances such as methyl mercaptan, trimethylamine, ammonia, and toluene. The project "Research on microbially derived coagulating agents" (budgeted for Y15 million through FY90) is to develop a microbially derived, biodegradable and non-polluting coagulating agent for rhodococcus (erythpores) for water treatment.

In the Human Frontier area, the following four projects are listed. First, the project "Molecular biological research of sugar proteins concerned with shape formation" (budget of Y11.5 million through FY90) will examine by means of molecular genetic methods the process of tissue formation from cells. The project "Research on the information manifestation control by plant genes" (budget of Y7.6 million through FY90) is to grasp, at the molecular level, the status (proliferation and differentiation) of cells growing on plant hormones. The project "Research on proteins capable of controlling genetic manifestations" (budgeted for Y1.5 million through FY90) is to clarify the molecular mechanism in the processes of genetic manifestation from DNA to protein to RNA to protein. Finally, the project "Research on the mechanism for molecular aggregate formation concerned with the energy transformation functions" (budget of Y8.6 million through FY90) will try to develop a measurement method for photoelectric initial reactions by clarifying, at the molecular level, the functions of light energy transformation and electron transmission of photosynthesizing crude bacteria.

[28 Jun 88 p 5]

[Text] Electrotechnical Laboratory

Challenge Unexplored Instrumentation Technology

The total FY88 budget for the Electrotechnical Laboratory (EL) is Y9.12 billion, which is lower than FY87's Y9.447 billion. Eleven new projects in the special research outlay will begin, including superconductive electronics and unexplored instrumentation technology with the space information center. Simultaneously, a large-scale project, i.e., research of elemental technology evaluation of a sophisticated fabrication device for power plant construction materials, a next generation project for the development of superconductors and superconductive chips, and the Moonlight Program's research project on sodium thermoelectric conversion technology will be initiated. In addition, EL will participate in projects related to the Human Frontier Program. Thus, EL is developing aggressive research activities.

Among the new projects in the special research outlay, the project "Unexplored instrumentation technology with space information center" (budget of Y28 million through FY93) aims to develop noncontact and nondestructive precision instrumentation technologies to gather information on the nature of solids, liquids, gases, and biological and complex

materials which are invisible to the naked eye. The project on "Basic research on superconductive electronics" (budget of Y10 million through FY92) is to clarify the characteristics of superconductivity phenomena which are expected to become useful in the development of electronic technology; specifically, the goal is to clarify the microscopic mechanism of the metallic electron theory, superconductivity non-linear phenomena, and critical electric current.

In the project for "New materials with optical control functions" (budget of Y22 million through FY92), materials will be sought, which will permit signal processing such as mutual action between light and electricity, light and magnetism, and light and light. The results are necessary to the development of the next generation optical information communication system. In another project, "Research to explore new fields of STM" (budget of Y26 million through FY91), the electronic properties of solids and organic molecular functions will be analyzed using the scanning tunnel microscope (STM) and the scanning tunnel spectroscope (STS).

The project, "Basic technologies of large-scale satellites" (budget of Y35 million through FY92), will promote research on the space teleoperator and thermal energy storage technology which are indispensable for the development of the infrastructure for the space base or platform. Outside the special research outlay, the objectives of the next generation project, "Development of superconductors andsuperconductive chips," are the synthesis of materials linked to the clarification of mechanisms in new superconductors, the design of new materials from oxide superconductors, the search for organic thin film-base superconductors, and the development of superconductive chips.

In the area of the elemental technology evaluation research of a sophisticated fabrication device for power plant facility construction materials, a segment of the large-scale project domain, the large diameter, large output excimer laser beam device will be developed in the project "Evaluation of beam generation technology" (budget of Y15 million through FY93). In the project, "Evaluation of the fabrication technology for power plant construction materials" (budget of Y7 million through FY93), the goal is to develop the evaluation technology for combined ion beams of ultra-low energy and medium to high energy.

Under the Moonlight Program, the development of a several hundred-watt-level thermoelectric convertor and the conceptual design of a several hundred-kW-level thermoelectric convertor will be pursued with the project "Sodium thermoelectric conversion technology" (budget of Y7 million through FY93). In the Human Frontier Program domain, research will be undertaken on awareness, recognition, motion and behavior control, on memory and learning functions, and on energy conversion functions.

In addition, with the U.S. National Bureau of Standards, a cooperative research project is to be carried out concerning the precision evaluation of new superconductors and the development of precision instrumentation devices using the superconductors. Also, in the health and welfare domain, the high speed three dimensional NMR-CT imaging method will be studied.

Research Institute for Textiles and Polymers

High Efficiency Deodorization Technology Among Three New Projects

The total FY88 budget for the Research Institute for Textile and Polymer (RITP) is Y1.55 billion. There are three new projects in the special research outlay, including research on synthesis of polymer network and its functionalization, and, under the automatic sewing system, a large-scale project of research on the flexible sewing subsystem. RITP will also participate in the next generation project of research on superconductors and superconductive chips, as well as in projects related to the Human Frontier Program.

The special research project, "Control of the structure of organic thin films by the gas phase method" (budget of Y10 million through FY92), aims at a method for precise control of the molecular structure which is necessary for the development of new organic materials such as optical and electronic materials. The first step will be the development of an organic molecular beam vapor deposition device.

In the project for "Research concerning synthesis of polymer network and its functionalization" (budget of Y10 million through FY91), polymers, which show a network structure, will be synthesized to develop new functional materials, and the relationship between the polymer structure and the network structure will be clarified. In the project for "The high efficiency deodorization technology" (budget of Y11 million through FY90), the goal is to establish a new high efficiency deodorization technology by developing functional polymers which can separate, concentrate and catalytically decompose odor-causing substances, odor decomposition-capable microorganisms, and polymers to immobilize microbial groups.

In the next generation project, "Superconductors and superconductive chips" (budget of Y10 million through FY91), research will be carried out to prepare adhesive materials for the organic compound superconductive thin film system to gain the possibility to control the characteristics of superconductivity using organic matter.

To be carried out in the Human Frontier Program domain are the project of "Research on the manifestation of electrochemical functions by enzymes having a redox center" (budget of Y8 million through FY90), to study techniques having the electron exchange function between a redox functional factor and an electrode; the project, "Activity control mechanism of nerve transmitting peptides; finally, the project "Research on energy conversion mechanisms in biological activity" (budget of Y11 million through FY90) to clarify biological activity by studying the reaction mechanism of a kinetic ATP hydrolytic enzyme.

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[Text] National Research Institute for Pollution and Resources

Aims at Use of Discontinuous Base Rock

The total FY88 budget for the National Research Institute for Pollution and Resources is Y3.721 billion, down from FY87's Y4.560 billion. Thirteen new special research projects and 37 new ordinary research projects are planned.

First, in the special research project, "Research on safety evaluation of discontinuous base rock" (budget of Y25 million through FY92), the plan is to establish a safety evaluation method for base rock use and deep coal mining and disaster prevention technology. The goal is to develop discontinuous base rock use technologies. The technologies are indispensable for the construction of an underground power plant, the storage of a huge quantity of energy, the storage of radioactive waste, and the storage of petroleum.

The project, "High temperature heat pipe" (budget of Y11 million through FY91), will promote the development of the high temperature heat pipe which will be the key technology for establishing ahigh efficiency heat transport system and a heat exchange system for space power devices or high temperature places on the ground.

In the project, "Technology of isolation and refining of Chinese rare metals" (budget of Y2 million through FY92), which is the study of hard-to-process rare metal ores produced in several places in China. The objectives are to develop a rapid quantitative analytical method for rare metal elements, a method for phase separation of minerals, and a method of refining minerals to high purity. In the project, "Technology to process chemical substances in effluent with supercritical fluid" (budget of Y25 million through FY91), the effluent containing chemical substances in high concentration or several inorganic salts will be treated with a supercritical liquid in a counter-flow contact and useful materials will be recovered.

In the project, "Prediction technology for optimal location through the clarification of the transition process of a shallow sea environment over a long period" (budget of Y32 million through FY92), will research environmental assessment for the large-scale development of an entire bay or multiple industrial districts by taking into consideration influences from the redevelopment of expanded sea areas or from topographical changes. The project, "Prediction and automatic measurement technologies for changes of plankton composition in the coastal areas" (budget of Y5 million through FY92), will try to develop a system which processes information on the number and variety of plankton and is necessary for the observation of nutriment-rich sea areas.

Other projects include "Technology of controlling atmospheric emission of volatile organic halogen compounds" (budget of Y20 million through FY91), "Evaluation and measurement method of source-generated dust, in consideration of its relationship with atmospheric particles" (budget of Y24 million through FY91), "Highly efficient treatment method for harmful chemicals through ecological control of active sludge" (budget of Y18 million through FY92), "Treatment of industrial waste containing harmful organic compounds" (budget of Y23 million through FY92), "Diffusion prediction and monitoring method for environmental pollutants affecting advanced technologies" (budget of Y37 million through FY92), "Atmospheric pollution simulation model" (budget of Y25 million through FY90), and "Development of a prediction method for water pollution" (budget of Y22 million through FY88).

Industry Products Research Institute

To Develop Low-Frequency Noise Evaluation Method

The total FY88 budget for the Industry Products Research Institute (IPRI) is Y1.43 billion, down from FY87's Y1.447 billion. The special research project of "Research on psychological and physiological measurement of variable low-frequency noises" will be initiated. The Human Frontier project for R&D of biological function-applied industrial technologies, three IPRI priority research projects, and nine projects in the new current research outlay will also be pursued.

The special research project "Research of psychological and physiological measurement of variable low-frequency noises" (budget of Y18 million through FY91) is aiming at establishing a method to evaluate low-frequency noises generated by the expansion of the traffic system and factories. The research is to record variable low-frequency noises, quantify their characteristic factors, synthesize simulated low-frequency noises, and analyze psychologically and physiologically the human reactions to the synthesized noises.

In the Human Frontier domain, the project for "Research of inter-sensory information integration mechanism" (budget of Y9 million through FY90) will be pursued to clarify the integration of information by the five senses by studying perception which is the function of recognizing outside conditions, and inter-sensory information. The two projects for "Brain's processing mechanism for super-parallel and dispersed information" and "Research of self-organized plexus of motion" (budget of Y11 million for both through FY90) will be taken up to elucidate the brain's information processing mechanism. These projects will study a model of a self-organization mechanism based on nonlinear interactions at the nerve element level, an architecture model of self-organized information processing and control at the plexus level, and the comparison of these models and physiological and psychological knowledge in regard to super-parallel motion control by the hand. In the project, "Construction of molecular receptor model" (budget of Y7 million through FY90), ingenious

molecular recognition mechanisms, which are characteristic of the living body, will be studied with model molecules equipped with the molecular recognition capability for ionic and neutral low molecular weight substances.

In the IPRI priority research project, "Research of fluidity change of fatty membranes" (budget of Y6 million through FY90), an attempt will be made to clarify the stimulation and response mechanisms of fatty membranes of the living body. The project, "Mathematical, physical, and engineering research of information processing and the control mode of motions by the cranial nerve system" (budget of Y5 million through FY89), will clarify the neural architecture of the motion control circuit. The project for "Research on parallel processing of sensory information" (budget of Y4 million for FY88 only) will aim to intellectualize the sense sensors.

In addition, with the support of the Special Coordination Funds for Promoting Science and Technology the projects for "Biological interaction-capable materials" and "Man-machine interface in machinery usage environment" will be started.

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[Text] Government Industrial Research Institutes (GIRIs)

Agency of Industrial Science and Technology

The Agency of Industrial Science and Technology has under its jurisdiction seven government industrial research institutes. Each institute is engaged in national research projects and other projects, which are closely related to its local economy. Here, some unique projects, such as important local technologies and international research cooperation, will be discussed.

GIRI, Hokkaido

New Process for Supermicro-Particles

The total FY88 budget for the GIRI, Hokkaido, is Y1,152.779 million. The budgets for R&D-related domains are as follows: Y100 million for ordinary research, Y41 million for special research, Y40 million for local technology R&D, Y3.7 million for economic cooperation, Y11 million for the special coordination funds for promoting science and technology, Y43.9 million for national government pollution prevention test research, Y15.8 million for the special account for energy conservation technology R&D, Y119 million for new energy technology R&D, Y2.6 million for the local technology exchange project, and Y11.5 million for the joint government-private sector cooperative project. The full-time staff consists of 73 research and 24 administrative personnel, a total of 97.

The new R&D projects starting in FY88 include, in the special research outlay, research on a new production process for supermicro-particles and research concerning low-pollution studded tires are budgeted for Y7 million and Y8.7 million, respectively. Added to that is the designated

research project for study of an energy-conserving production technology for fine ceramic raw materials, with a budget of Y8 million. However, the manufacturers of studded tires have already decided to discontinue production after 3 years because of having to cope with the powdery dust pollution problem, so the content of the project is expected to change before completion.

Among the remainder of the continuing research outlay, one project, which is unique to Hokkaido, is research concerningthe technologies of peat granulation and its conversion to energy. Peat is known to be deposited in large quantities near the surface of the earth in the central and eastern parts of Hokkaido Prefecture, and is expected to draw attention as a local energy source in the future. In the local technology development project domain, in addition to the project (special account) for demonstration tests of the heat pump for cold regions, the project for a cold region sophisticated automatic snow removal technology is planned.

Sapporo City has the largest snowfall among cities of one million population in the northern region. The snowfall is a serious hindrance to the city's economic activities. To cope with the problem, Sapporo City started a snow removal program, matching the high technology era by establishing the Snowtopia Plan. But, GIRI, Hokkaido, will work separately on high speed, safe snow removal. Actually, the development of new snow removal vehicles of the rotary and the plug-type has been under way since FY87. Even though information has been exchanged with Hokkaido Prefecture and Sapporo City, GIRI, Hokkaido, has no intention of linking its R&D work with the others.

Among the international research cooperation projects, there is a joint research project with the People's Republic of China concerning the new fluid bed coal combustion technology.

GIRI, Tohoku

Rare Metals Separation & Refining, Joint with PRC

The total FY88 budget for the GIRI, Tohoku, is Y385.834 million, a decrease of 1.9 percent from FY87. The main research projects are the use of the subterranean heat, the use of resources, ceramics, biotechnology, and mechatronics. The objective is to establish futuristic key technologies by taking advantage of local features of the Tohoku district. The largest single budget item is the R&D project for thenew energy technologies, including the development of materials using subterranean heat and the total use of subterranean heated hot water. The project is incorporated in the Sunshine Program of AIST.

Leading the list of international research cooperation projects for FY88 is the joint research project with the PRC concerning the separation and refining technologies for rare metals (rare and scarce metals). Together with the National Research Institute for Pollution and Resources in

Tsukuba City, GIRI, Tohoku, has a 5-year program with the PRC's counterpart, Kwangchou Provincial Colored Metals Research Institute. Approximately 15 Japanese researchers are scheduled to be dispatched to the Provinces of Kwangchou and Hunan.

The project's targets are heavy rare earth metals, such as lanthanum, yttrium, and scandium, which will be separated and purified as chlorides.

The separation and purification of rare metals will be studied along with the project for "Research concerning the development of compound materials by intercalation" in the Tohoku district too, by the important local technology R&D system. In both projects, accumulated know-how in the refinery technology of the Tohoku district will be used fully.

In addition, the Moonlight Program will continue the project "Research concerning an energy conserving production process for high melting point inorganic compounds." The project is for R&D of the simultaneous synthetic molding technology using the auto-heating reaction.

Others include the project for "Research concerning the structural control technology for functionally gradient materials," which could develop a production method for the cover material for space shuttles or rocket engines; the project of "Research concerning technologies of high yield isolation and purification of active components from biomass," which aims to increase the values added for low-utility biomass and to produce high-purity products; finally, the project for "Research concerning the evaluation technology for fabrication materials by residual stress measurement," which attempts to measure in real time the residual stress distribution inside fabrication materials with supersonics or microbeam x-rays and to analyze the process of stress generation.

[6 Jul 88 p 6]

[Text] GIRIs, AIST (Continued)

GIRI, Osaka

Emphasis on "Materials" Research

The FY88 budget, except for the personnel expenditure for the GIRI, Osaka, is Y988 million, which is approximately Y79 million (or 7.4 percent) less than FY87. Budget categories include Y233 million for ordinary research, Y196 million for special research, Y515 million for designated research, and the remainder for others. Within the revised budget of FY87 an addition was made to the new material experimental laboratory building, and the material technology center was reorganized. The objective of these moves is the production of new materials using an ion injection device and the reinforcement of research in the area of material instrumentation and evaluation.

There are 28 projects in the ordinary research category. Seven of them will be carried out as Osaka GIRI priority research projects, which include five new projects, such as research on graphite double layer interlayer compounds, research on the creation of physiologically active materials, and research on electrode materials for the formation of ozone using solid polymeric electrolytes. The special research category has 17 projects. A new research project to study the structural control of whisker complex ceramics has been started. Its objective is to examine the preparation method to be used in the development of complex ceramics with excellent toughness and the relationship between its toughness and structure.

In the designated research outlay, Y99 million is budgeted for large-scale industrial technology-related projects, Y103 million for new energy technology projects, Y228 million for energy conservation projects, Y8 million for medical and welfare equipment technology projects, Y45 million for the next generation industrial key technology projects, and Y32 million for important local technology projects. Among the large-scale industrial technology projects, the project of the observation system for resource search which is in charge of the high power infrared emission detector will be closed at the end of FY88, and in the super advanced fabrication system project, which began full-scale activity in FY87, more impetus will be given to research of the ion beam process technology.

Four projects, including the hydrogen production method and hydrogen storage by impregnated alloys, will be continued among the new energy technology-related projects. In the energy conservation area, the ongoing projects of the new battery electric power storage system and the fuel cell, respectively, shift their emphasis toward research of capability evaluation and material evaluation. The project for research on the high lithium ionic conductive solid electrolytes has been added as the leading key energy conservation technology.

Elsewhere, the 2-year project in the medical and welfare-related area to study the removal of arteriosclerosis by laser has started. Research projects of the high temperature superconductor material synthesis and the production process for ceramics gas turbine for the gasification of coal have started in the next generation industrial key technology area. In the important local technology area, the 5-year cooperative research project on the evaluation of the comfort of clothing using mannequin robots is in its final fiscal year.

GIRI, Nagoya

Emphasis on Fine Ceramics

The Nagoya GIRI plans to pursue selectively, as priority, the development of materials, including ceramics, and of related technologies. The areas of designated research and special research list the projects which emphasize basic research to dig up ideas for thefuture. Of 47 projects

in the area of ordinary research, 31 are connected with ceramics. Its total research budget is Y820 million. The number of projects in the next generation industrial key technology area has increased conspicuously.

The next generation industrial key technology projects in the designated research outlay include "Evaluation of elements of the ceramic turbine for coal gasification" in its third term, and three new sub-projects, including "Toughness improvement technology." The new project of "Development of new processing technology for high temperature superconductors" begins a 10-year program. In the energy technology area, the project for "R&D of heat-resistant ceramic parts materials" will begin in connection with the ceramic gas turbine engine project of the Moonlight Program.

In the area of important local technology, the project of "Development of synthesis technology for artificial clay, a raw material for new ceramics," for which the local area has high hopes, will begin as a 5-year program. This project is in response to the depletion of quality clay resources. In the mining industry special research area, the project for "Research concerning the improvement of functions of high temperature superconductors" will start anew.

Replacing the project of fabrication standards for fine ceramics, the 3-year project for "Research concerning the mass production-type full mold method" will be a new project in connection with the technology to aid mid- and small-size enterprises. The project, "Research concerning the quantum effect in a radiation environment," has also been added. In the areas of pollution prevention and international industrial technology, "Chinese clay" and "Colors of rare earth-containing ceramics" will continue. Two projects will also continue in the area of joint government-private sector cooperation research. Three new projects, including "Improvement of surface properties of structural materials by metals," will start in the area of priority basic research.

In FY87, the Nagoya GIRI worked on 49 ordinary research projects, of which five have been completed. In FY88 five new projects, including "Evaluation of physical properties of superfine ceramics," have been added. The breakdown shows 31 projects on new material technology, six on industrial base establishment technology, four on pollution prevention technology, three on bionics general research, two on consumer science technology, and three on others. Of these, 31 projects are connected with ceramics. Together with projects in the designated and special research areas, they back up the magnitude of the institute's research emphasis on ceramics technologies.

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[Text] GIRIs, AIST (Continued)

GIRI, Chugoku

Two Pollution Prevention Projects to Start

The total FY88 budget for the Chugoku GIRI is Y340.932 million, which is only a 3.1 percent increase from FY87.

The key in each research category is as follows. (1) In the designated research category, although one project related to the new energy technology development was completed at the end of FY87, another project related to important local technology R&D, "R&D of a visual recognition and differentiation system in production technology," will operate at full-scale. (2) In the Institute's special research category, the main core is the continuing projects including research of a local industry base establishment technology. (3) In the pollution prevention special research category, one project was finished but two new projects will start to deal with closed sea areas.

The project "R&D of visual recognition and differentiation system in production technology" started in FY87 as a joint industry, academe, and government cooperative research project based on the important local technology R&D project. Now, the research system has been organized and full-scale research activities will begin in FY88.

The project, to cope with multi-product small-volume production, aims to establish a visual detection sensor and recognition system technology in fabrication and assembly lines. The new laboratory building, the center of research activities, was completed by March 1988. Fresh research equipment, such as a 32 bit superminicomputer and a laser impact material evaluation device, has been installed.

Newly starting projects in the pollution prevention special research category are "The study of cleaning the migratory organic mud in closed sea areas" and "Research of survey and evaluation techniques for current movement and material migration caused by winds in closed water areas."

These projects will pursue the examination of contaminants in closed water areas, such as the Inland Sea and Tokyo Bay, for the advancement of environment preservation. The research terms are 5 and 4 years, respectively.

GIRI, Shikoku

Recycle of FRP Wastes

The total FY88 budget for the Shikoku GIRI is Y470 million, up from FY87 by Y5 million. Two of three designated research projects and one of eight special research projects are new.

In the designated research category, the research project will start jointly with public experimentation and research organizations and private industries in the Shikoku district, on "Recycling system technology for complex materials (FRP wastes)" based on the important local technology R&D system. In addition, for application of biological functions to industry, the project, "Research on molecular recognition by interaction between cell surface layers and polysaccharides," will begin.

To be pursued in the special research category is the project for "Development of magnesium pyroborate fiber," which is attracting notice as new material, as well as the technology development project for the production and applications of functional sheet materials to be made from acid polysaccharides, the main constituent of seaweed.

As a technology to collect rare and scarce solubilized resources in sea water, the project, "Research concerning the development of a high power adsorbent for uranium and lithium," which seeks to produce a high power adsorbent to collect uranium and lithium in sea water, will continue from FY87, and so will the project for "Industrialization tests for the conversion of palm oil byproducts to TMP," which was requested by Malaysia.

Furthermore, in cooperation with local public research organizations, developmental work will be done to produce chitin-base polymer as a chromatographic carrier from chitin, which is contained in shrimp and crab shells, and apply the polymer to the paper and food industries.

Also continued from FY87 is the project, "Research concerning the production technology for multi-component complex microparticles," based on the joint government and private sector cooperative research system. The two ordinary research projects, "Research of control with long arm servo mechanisms" and "Research of thermal fabrication of marine buildings," are new.

GIRI, Kyushu

Fine Chemicals from Lime

The total FY88 budget for the Kyushu GIRI is Y914 million, an increase of Y10 million over FY87. New projects are two out of 10 in the special research category, one out of four in the designated research category, and 16 out of 36 in the ordinary research category.

The new special research projects are "Production of multi-functional microspheres (micro-size spherical particles)," which seeks surface improvement of particles, and "Development of intelligent complex ceramics," which aims at the creation of new complex ceramic materials combining a structural material and a functional material capable of emitting signals about temperature and damage conditions.

In the multi-functional microsphere project, particles will be coated with another material to provide two-stage actions and/or the surface of particles will be made porous to be capable of absorption. Some microspheres are already in use in medical supplies, and other uses are anticipated in agricultural chemicals, electronic parts, and thermits.

The intelligent complex ceramics will be developed as a material for the primary wall of a nuclear fusion reactor. Because of its sensor functions and high dependability, its use in aircraft and smelting furnaces can be considered.

The important local technology is "Technology to produce fine chemicals from lime." Specifically, the crystal form control system will be developed for calcium carbonate and calcium silicate, which are produced from lime stone which occurs abundantly in the Kyushu district, and the technologies will be established for their applications as a foreign paper filler and as a filler substitute for asbestos.

In the ordinary research category, new projects include "Selective separation of strontium," "Improvement of compatibility at the interface in metal-base complex materials," "Fluid molding of powder paste," and "Functionalization of carbon electrodes."

Finally, with the subsidy from the Special Coordination Funds for Promoting Science and Technology, three projects will be carried out: "Synthesis conditions for fine-structured functional materials," "Separation and recovery methods for rare and scarce valuable metals," and "High plasticity fabrication of complex materials."

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[Text] Geographical Survey Institute

Underground Map Database

The total FY88 budget for the Geographical Survey Institute (GSI) of the Construction Ministry is Y8.113 billion, a slight increase from FY87's Y8.096 billion. GSI will be full of aggressive research activities. For example, it will participate in the general technology development project of the Ministry of Construction, "Technological development of underground space use," and it will start the project "Research of satellite survey systems for application to construction technology," a joint government and private sector cooperative research project, aswell as the project, "Aircraft survey technology for intertidal zone contamination," taking advantage of the pollution prevention experiment and research outlay.

The project, "Research concerning the development of technology for the use of underground space" (budget of Y5 million through FY91), will aim to develop an underground map database system and a three-dimensional graphic technique, both of which are indispensable for the underground development demanded by the sophistication of major cities. Surveys will

be made of the state of art of the underground map and of the needs in each major city. Also to be studied are the items to be indicated, input methods, and graphic techniques for underground maps.

Another research team will be added to the FY87-initiated project for a disaster information system to pursue the specific project, "Development of technology to superimpose a video image and a topographical map" (with a budget of Y21 million through FY89).

In the joint government and private sector project, "Development of the application technology of the satellite survey system to the construction industry" (budget of Y7 million through FY90), the goal is to develop a system, which, using GPS, can do rapid and easy survey with high precision, and is useful in large-scale construction projects.

In the project, "Survey technology for intertidal zone contamination by aircraft imaging" (budget of Y22 million through FY91), the two objectives are the development of a simple analytical graphics drawer to analyze quantitatively intertidal zones from air photographs and the survey of contamination in atoll regions.

The project, "Earthquake tectonics in the Central Japan's active structural regions" (through FY89), will use the Special Coordination Funds for Promoting Science and Technology to survey the active fault movement in the Suwa area in Nagano Prefecture and the detailed distribution of strain in the earth's crust along the line from Matsumoto to Nagano to Iiyama.

In the general research category, the project for "Research concerning the land survey system by GPS" (budget of Y4 million through FY90) will be initiated. Its objective is to establish the position survey error correction method and apply the high precision three-dimensional survey technology by the year 1990, when the total earth scale observation system by man-made satellites will have been established.

Furthermore, GSI plans to pursue the projects "Applications of the classification technique for land cover by MOS-1 data" (budget of Y3 million through FY89), "Research concerning the regional characteristics of year-round changes caused by vertical motion of the earth's crust" (budget of Y6 million through FY89), and "Research in the preparation of topographic maps of the 1/25,000 scale by the digital technique" (budget of Y4.5 million through FY90).

Building Research Institute

New Reinforced Concrete

The total FY88 budget for the Building Research Institute (BRI) of the Ministry of Construction is Y1.673 billion, a slight increase from FY87's original budget (subtracting the supplementary budget) of Y1.666 billion (y2.147 billion with the supplementary budget).

BRI will promote two new projects under the general project of the Ministry of Construction. They are "Development of technologies to build super-light weight and super-high rise reinforced concrete buildings" and "Development of application technologies for new materials." To deal with the asbestos problem, a social issue due to its environmental contamination, the project for "Technical methods to cope with pollution problems caused by asbestos-base materials in construction" will be taken up by using the pollution prevention research funds. Also, BRI will challenge new projects connected with the Water Frontier Program.

The project, "Technologies to build super-light weight and super-high rise reinforced concrete buildings" (budget of Y27 million through FY92), will develop new and sturdier reinforced concrete, which has yield and compression strengths two to five times greater than the previous reinforced concrete. Examinations will be made of cement, hard skeleton materials, least water requiring blend additives, and micropowder blend additives. The objectives of the project "Development of application technologies of new materials" (budget of Y21 million through FY92), are to develop new fiber reinforced concrete, external thermal insulation structures using complex materials, and high function energy-conserving illumination using optical fibers.

In the anti-asbestos pollution project, "Anti-pollution technical methods for asbestos-base building materials in construction" (budget of Y6 million through FY90), the objective is to prepare a manual of countermeasures to prevent environmental contamination by asbestos-base building materials. The research activities include the development of technologies to prevent contamination during construction and to prevent dust formation during construction or demolition.

The Water Frontier Project, "Anti-earthquake measures and basic engineering methods for soft ground zones" (through FY90), will develop a survey method for reclaimed ground to establish an appropriate engineering method and comprehensive anti-earthquake measures for soft ground zones.

In the most advanced technology development category, the project for an "Optical fiber simple seismometer for wide areas" (through FY90) will be carried out to develop a sturdy yet handy, and easily operable earthquake observation device. The project for "Architectural technology for the creation of new marine residential areas" (through FY90) will be carried out to create additional living space over the sea.

In addition, research activities are planned to study the deterioration mechanism in building materials, the psychological evaluation of the environment of housing complexes as viewed from the stages of life, and a design method for simple air-conditioning.

Public Works Research Institute

New Material for Public Works Structures

The total FY88 budget for the Public Works Research Institute (PWRI) of the Construction Ministry is Y7.93 billion, a decrease of Y440 million from FY87. Participating in the newly begun project for "Development of application technology for new materials to the construction industry," the general technical development project of the Ministry of Construction, PWRI will pursue "Development of application technology of an expert system for public works structures," which is a PWRI special research project, and six joint government and private sector cooperative research projects.

The objective of the project, "Development of application technology for new materials for the construction industry" (budget of Y32 million through FY92), is to introduce new materials to public works structures. Attempts will be made to use new light-weight but strong materials such as carbon fiber for the cables of suspension bridges and cable-stayed bridges, and to develop light-weight but strong super-concrete, which would enable the construction of a long bridge of the 4,000 meter-class. Other materials to be developed include a highly wear-resistant paving material such as rubber-containing asphalt, a land fill material using polystyrene foam, a new polymeric material for ground injection to improve dam foundation base rock, and a mud slide stopper using a highly water-absorbent polymer.

The objective of a special research project, "Development of application technology for an expert system for public works structures" (budget of Y6 million through FY90), is to develop an expert system for public works structures by converting experts' know-how into a data base. Its immediate goal is to develop a program for the selection of the form of a bridge. In the program for "Research for control of earth and sand in river regions" (budget of Y2.55 million through FY90), soil survey will be conducted for an entire river region and countermeasures will be examined for the region to be able to control earth and sand which accumulate in dams and water reservoirs, and decrease in the downstream sections.

Included in the six new joint government and private sector cooperative research projects are "Development of a control system for excavation of small diameter ducts" (budget of Y7.7 million through FY90) using AI (artificial intelligence) and robots, and "Development of technology to use underground space" (budget of Y19 million through FY91) to achieve efficient land use in major cities.

In addition, PWRI will begin an independent project, "Research concerning the disinfection and sterilization of treated sewage" (budget of Y10 million through FY90), using ozone and ultraviolet light to sterilize sewage.

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[Text] Forest and Forest Products Research Institute

Elucidation of Characteristics of Pulse Family Trees

The total FY88 budget for the Forest and Forest Products Research Institute (FFPRI) of the Ministry of Agriculture, Forestry and Fisheries is Y6.854 billion, an increase of 1.9 percent over FY87. In FY88, particular emphasis will be placed on the special research project, "Elucidation of the physiological mechanisms of principal trees in the pulse family, and development of cultivation technology for their saplings," which is promoted by the Agriculture, Forestry and Fisheries Research Council. Also, to be emphasized in FY88 are a general research project, "Improvement of water preservation and control functions in agriculture and forestry," and a joint government and private sector cooperative research project, "Development of track-laying, irregular land-travelling couple-capable vehicles for forestry," to be carried out jointly with Kaneko Farm Machinery Co., Ltd.

In the category of the FFPRI's designated research, it plans to promote four projects including management planning methods for forests in the suburbs of major cities, and two specified research projects including the development of sensing technology for forestry mechanization. FFPRI will participate in the reorganization of the National Research Institute of Forestry which is scheduled in October 1988.

In the special research project of "Elucidation of the physiological mechanisms of principal trees in thepulse family, and development of cultivation technology for saplings" (budget of Y12 million through FY91), studies will focus on the following: the elucidation of mechanisms of high temperature characteristics and extreme environment characteristics (such as growing in poor-quality soil areas) of trees in the pulse family, such as acacias, and in the black alder genus of the birch family; and the development of new cultivation technology for saplings using microorganisms by analyzing the work of symbiotic microorganisms such as the root nodule-forming bacteria unique to the pulse family plants and the VA root bacteria.

The goal of the microbial natural enemy-utilizing project, "Technologies for improving the functions of useful biological natural enemies and of combating and eliminating new harmful insects" (budget of Y2 million through FY90), is to develop an insecticidal technology against harmful insects using insect-parasitic thread worms.

The water preservation capability of each farm and forest area which has greater ability to hold and control water will be examined with the general research project, "Research to improve water preservation and control functions in agriculture and forestry" (budget of Y19 million through FY90). The work to clarify the functions of tree-produced substances will be started with the "Large-scale separate project for development of

new technologies for agriculture, forestry, and fisheries through the clarification and control of biological information" (budget of Y11.8 million through FY97).

The objective of the project "Development of tracked, all terrain couple capable vehicles for forestry" (budget of Y6 million through FY90) to be carried out jointly with Kaneko Farm Machinery Co., Ltd., is to develop vehicles which run on sloping wooded land. In the institute's own research category, FFPRI has the project of "Development of sensing technologies for forestry mechanization" (budget of Y8 million) and the project of "Development of properties and biological activation functions of charcoal" (budget of Y2.9 million), which examines the use of charcoal with an adsorption-immobilized useful microorganisms for cleaning water and air.

National Institute of Agro-environmental Sciences

Use of Biological Natural Enemies

The total FY88 budget for the National Institute of Agro-environmental Sciences (NIAS) of the Ministry of Agriculture, Forestry and Fisheries is Y2.568 billion, a decrease from FY87's Y2.735 billion. The main reason for the decrease is the decrease of the construction outlay due to the completion of the biological test laboratory. The experiment and research outlay is about the same as FY87.

The NIAS will act as the institute-in-charge for the ministry's special research project for "Technologies to improve the functions of useful biological natural enemies and to combat and eliminate new harmful insects"; its research activities include the improvement of the proliferation, attack, and the insecticidal power of natural enemies. The NIAS will also participate in the development of new agriculture, forestry and fisheries technologies through the clarification and control of biological information, and the project to improve water preservation and control functions in agriculture and forestry. It will also promote the expansion of the development and application of new nuclear reactor technologies in the agricultural environment research category.

In the project to develop new technologies to combat and eliminate harmful insects by using the functions of insects' biological natural enemies (budget of Y2.9 million through FY90), studies will be done on the proliferation by man-made eggs of polyphagous natural enemy insects, the improvement of insecticidal technology, the improvement of the proliferation, attack, and insecticidal capability of biological natural enemies. In the project on the improvement of water preservation and control functions in agriculture and forestry (budget of Y13 million through FY93), the mechanism of water movement in farm soil will be examined. Under the development project for new agriculture, forestry and fishery technologies through the clarification and control of biological information, research will be pursued on abnormal dormancy (budget: Y9 million), environmental adaptation (budget: Y16 million), biological defense (budget Y17 million), and supermicroanalysis (budget: Y10 million).

In the project of "Expansion of applications and development of the new nuclear reactor-applied technologies for agricultural environment research" (budget of Y21 million through FY97), which uses a nuclear reactor, studies will be done on new activatable tracers, a direct marking method for agricultural materials, structural analysis using cold neutrons, and material movement in the agricultural environment.

Participating in the developmental research project of the diffusion prediction and monitoring methods for environmental contaminants in connection with the advanced technology industries, theNAIS will investigate the movement of fatty chlorine compounds and rare metals in the agricultural environment (budget of Y18 million through FY92). The work entails the examination of the changes of such chemicalsas trichloroethylene, beryllium, and silver, in soil, farm products, and water, and their influence on vegetables.

In addition, the NAIS will challenge the projects on "Search for characteristic biological life and the analysis of the host and parasite relationship in the agricultural environment" (budget of Y11 million) and "Clarification of atmospheric methane movement in the agricultural ecological system" (budget of Y13 million) under the priority basis research category.

National Agriculture Research Center

Unmanned Agricultural Work System

The total FY88 budget of the National Agriculture Research Center (NARC) of the Ministry of Agriculture, Forestry and Fisheries, is Y3.131 billion, about the same as FY87. The NARC will participate in the joint government and private sector exchange cooperative research project, which was inaugurated in FY88, to pursue three projects, including "Development of an energy-saving and high-precision remote cultivation control system," jointly with Yanmar Farm Machinery Co., Ltd., and "Symbiotic mechanism with host as observed in a slightly toxic virus," under the biological information project category.

First, the objective of the project "Energy-saving and high-precision remote cultivation control system" (budget of approximately Y6 million through FY90. Yanmar Farm Machinery Co., Ltd. will fund approximately the same amount toward the research expense.) is the development of a system which does all farm work without humans. The initial work will be to develop a remote control tractor which will become the base for the system. Farm land specifications (soil status and topography) will be put into a computer to schedule automatic slanting and fertilizing. In particular, the digital spectrum scattering communication method will be examined as the control method.

In one of the three biological information projects, "Symbiotic mechanism with host as observed in slightly toxic virus" (budget of Y2.3 million through FY90), the symbiotic relationship between cucumbers and mosaic

virus will be examined at the molecular level to find out what information is transmitted between them.

Through the project on "Mechanism for information recognition and transmission in the symbiotic phenomenon between the rice insect genus and microorganisms" (budget of Y9.3 million through FY90), the functions of the yeast-like microbe, which is a symbiont with the rice insect, will be studied. A sterol-material produced by the yeast-like microbe will be especially examined to develop a new chemical to alienate a symbiont. In the project for "Physiological mechanism of wheat's semi-dwarfness" (budget of Y2 million through FY90), the mechanism of dwarfness will be investigated at the molecular level to clarify the actions of genes.

In addition, NARC will promote the following in-house research projects: the crop rotation in a paddy field (through FY90) to increase the average yield of wheat, rice, and soy bean, by 20 percent (by crop rotation); the technology for super low temperature preservation of plant gene sources (through FY90); and the clarification of the method of land use programming for the agricultural collective residential areas (the white land areas) (through FY90) as a project connected with the direction of development of the land problem and the farm land policy at stage of industrial structure reorganization.

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[Text] National Institute of Agrobiological Resources

Preservation of Plant Genetic Sources

The total FY88 budget for the National Institute of Agrobiological Resources (NIAR) of the Ministry of Agriculture, Forestry and Fisheries, is Y2.625 billion; a slight increase from FY87's Y2.558 billion (or Y3.700 billion with the supplementary budget).

The NIAR will act as the institute-in-charge for the special research project of the Ministry of Agriculture, Forestry and Fisheries, "Super-low temperature preservation technology for plant genetic sources" (through FY90). In the project, the NIAR will do research on the examination of anti-freeze mechanisms, the problem of the destabilization of genetic information which occurs during re-differentiation, and a super-low temperature preservation technology for high-fat seeds. The NIAR also will be the institute-in-charge for the large-scale separate research project of "Development of new technologies for agriculture, forestry, and fisheries, through clarification and control of biological information" (through FY97). In the project, the NIAR will pursue research on the mechanism of the genesis and growth of an embryo, the differentiation of stem and leaf from a callus of a plant of the oryza genus, and the movement, dormancy, differentiation and recognition of stress in the growth of the invertebrate.

The NIAR will also participate in the projects supported by the Special Coordination Funds for Promoting Science and Technology. They are "Development of genetic engineering technologies" (through FY90), by which useful living organisms will be created using genetic engineering technologies; "Research on safety in the development system of recombinant DNA technology" (through FY90), which aims at the development of a microbial monitor using recombinant DNA technology; and "Development of technologies for chromosome analysis and application" (through FY90), to examine the functions of stabilizing structural factors of chromosomes, and to insert genes into the chromosomes of a monocotyledon.

The NIAR will also take part in two priority research projects on the "Manifestation and control mechanisms of genetic information on cauliflower mosaic virus" and "Control of the anti-freeze property of plant cells by plant hormones" (both through FY90).

In the government and private sector exchange cooperative research project category, the NIAR, in cooperation with Suntory Ltd., will promote the project, "Screening and application method for new anti-plant virus active substances produced by turf microorganisms of insects such as the rice insect and hopper" (budget of Y6 million through FY90). In the category of the inter-ministry research projects, using Ministry of Education Academic Research Funds, the NIAR will pursue the projects for the "Clarification of the interspecies characteristics of the omnipotent control factors of cells" (through FY90) and for the development of a new animal model through the cloning mechanism of chromosomes, the application of mulberry gene sources, and the insertion of foreign genes into DNA.

National Food Research Institute

Improve Fruit Quality

The total FY88 budget for the National Food Research Institute (NFRI) of the Ministry of Agriculture, Forestry and Fisheries, is Y1.573 billion, an increase of approximately Y60 million over FY87. With this budget, the NFRI will promote the following projects in the main: the project on "Examination of the main factors causing quality deterioration in high quality fruits and vegetables during production and distribution, and their control technology"; "Production of high activity freeze-resistant yeast by cell fusion," which is to be pursued jointly with Toyojozo Co., Ltd., as a part of the research project for new agriculture, forestry and fishery technologies through the clarification and control of biological information; finally, "Production of traditional processed fish products fortified with natural vitamin D_3" to be pursued jointly with Taiyo Fishery Co., Ltd. and the Tokai District Marine Research Laboratory.

The project, "Examination of main factors causing the quality deterioration of high quality fruits and vegetables during their production and distribution, and their control technology" (budget of Y3.7 million through FY90), will establish the technologies to improve the quality, particularly the

flavor, of melons, watermelons, peaches, tangerines, and tomatoes, and the analytical methods for sugar, organic acids, and amino acids. The project concerning biological information with a budget of Y58 million, will pursue the clarification of the molecular recognition and control mechanism, the molecular design of a multi-functional chimera enzyme, and the measurements of plant physiological changes with NMR. In cooperation with local agricultural experiment stations, an attempt will be made to develop a method to measure a food's tastiness.

With the inter-ministry basic research funds, the research project will start on the transcription control protein factors for genes related to plant-produced forms and characteristics by studying soy bean protein. Under the category of the government and private sector exchange cooperative research project, the NFRI will study "Creation of high-activity freeze-resistant yeast by cell fusion and its application technology" (budget of Y5 million through FY89) to develop a freeze-resistant bread yeast which will make it possible to make bread with frozen bread dough. Also, under the same category, the project for "Research concerning the production of the traditional processed fish products fortified with natural vitamin D_3" (budget of approximately Y20 million through FY89) will be tackled to improve the absorption of calcium via vitamin D_3.

Meteorological Research Institute

Problem Solving at Global Scale

The total FY88 budget for the Meteorological Research Institute (MRI) of the Meteorological Agency is Y2.176 billion, a decrease of a little more than Y40 million from FY87. The MRI will pursue the projects "Research concerning the optimal wavelength band," using the marine development and survey research promotion funds; and "Research concerning the distribution and movement of transuranium atoms in the environment," by using the radioactivity survey research funds. It will focus its activities on global meteorological problems and the earthquake problems.

The objective of the project, "Research concerning the optimal wavelength band" (budget of Y5.7 million through FY90), is to establish a temperature measurement technology for the sea surface considering the influences by atmospherically absorbed gases, aerosols, and air temperature.

In the project on "Survey research concerning the wide area distribution of radioactive gases originating from nuclear facilities" (budget of Y4.5 million through FY90), the MRI will, throughout Japan, measure radioactive gases, such as krypton 85 and tritium, which are emitted by the reprocessing of nuclear fuels. In the project on "Research of the distribution and movement of transuranium elements in the environment" (budget of Y5 million through FY90), studies will be done to clarify the mechanism of the distribution and accumulation of transuranium elements, such as plutonium and americium, which have a long life, strong radioactivity, and are of concern for environmental contamination.

Also promoted by the MRI are the projects on "Research concerning the transportation of contaminants related to acid rain in the eastern Asia region" (budget of Y18 million through FY91), using the pollution prevention experiment and research funds; "Research on the snow fall and accumulation mechanism" (through FY90) to study the man-made snowfall and the artificial control of snowfall, using the Special Coordination Funds for Promoting Science and Technology; and "Chemistry of the troposphere and the lower stratosphere atmosphere affecting climate change" (through FY90), using the international revolving basic research funds.

Additionally, the MRI will start 12 new general research projects, including "Research on a meteorological model" (budget of Y1.6 million through FY92), and "Research on the low-altitude wind-shear effect near airports" (budget of Y0.4 million through FY90).

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High Density Superconductive Ceramics

43067105a Tokyo NIKKEI SANGYO SHIMBUN in Japanese 27 May 88 p 3--FOR OFFICIAL USE ONLY

[Excerpt] On 26 May 1988 in the annual meeting of Japan Ceramics Society being held at the Japan Metropolitan Center in Hirakawa-cho, Tokyo, a succession of papers reported research accomplishments of high density synthesis and the wire formation, which are the key points in the application development of high temperature superconductors. The foundation for commercialization is being steadily strengthened.

The cooperative research group of Tokyo University, Mitsui Mining and Smelting Co., Ltd., and Fujitsu Ltd., developed a synthetic method for Y-base superconductive ceramics with extremely high density. Uniform and micronized raw materials are first hardened under high pressure and then sintered. The density, which was previously held at or below 80 percent, has now been elevated to 98 percent. It is promising as a production method, which allows an increase of electric current in a superconductive state and increases the strength.

The research group first mixed three solutions containing yttrium, barium, and copper, and used "the oxalic acid-ethanol method" to precipitate a powder compound, the raw material. The particle size of the powder is less than one micron (one micron is one thousandth of a mm), making the raw material homogeneous. After hardening under high pressure, it was heated to 1,020 to 1,200° C.

The previous powder blend method caused many holes in the sintered mass and the density never exceeded 80 percent. But, the new method raised the density to 98 percent. The material's electric resistance became zero at 90° K (-183° C). The measurement of electric current density in a superconductive state has not yet been made, but it is predicted that the density will be higher than previous sintered materials.

However, because it is necessary to heat the material for many hours in the presence of oxygen, the method is not immediately ready for mass production.

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Micron-Size Superconductive Ceramic Wire

43067105b Tokyo NIKKEI SANGYO SHIMBUN in Japanese 27 May 88 p 3--FOR OFFICIAL USE ONLY

[Text] Professor Sumio Sakuhana and others of the Chemical Research Institute, Kyoto University, developed a technology to produce super-ultra-thin wire with a diameter of 10 to 15 microns (one micron is one thousandth of one mm) from Y-base superconductive ceramics. Previously, there has been no method available to make wire with a diameter in the 10 micron range, though a technique has been studied to draw out wire after a metal had been packed in a metal pipe. Now, the wire's application to the development of superconductive coils and superconductive wiring can be anticipated.

Professor Sakuhana and his colleagues prepared mixtures of aqueous solutions of yttrium acetate, barium acetate, and copper acetate, and slowly evaporated the water. When the solution becomes thick and viscous, it is extruded through a fine nozzle under pressure. The resulting wire-shaped materials were sintered to make a superconductive ultrafine wire.

The diameter of the wire is 10 to 15 micron. Previously, the diameter of the thinnest test-produced wire was at best 0.1 mm. Thus, the diameter has been reduced to a level of one-tenth of what it was. The method of production is simple and highly practical.

The critical temperature to obtain a superconductive state is, for now, 62.1° absolute (-211° C), which is lower than the 90 degree absolute class of the yttrium-base sintered material. This is because of the formation of bubbles which produce air pockets during sintering, but its improvement is anticipated by finely controlling the methods of extrusion and sintering.

The fabrication of superconductive ceramics is difficult. However, by this method, any desired form, such as a coil, can be made at the time of extrusion. It will be useful to reduce the size of superconductive coils and for to advance research on superconductive wiring.

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Homogeneous Y-Base Superconductive Particles

43067105c Tokyo NIKKEI SANGYO SHIMBUN in Japanese 30 May 88 3--FOR OFFICIAL USE ONLY

[Text] The joint research group of Osaka Prefecture University (OPU) and Osaka Prefecture Radiation Central Research Institute (OPRCRI), and the research group of Tokyo Institute of Technology (TIT), separately and successively, succeeded in producing homogeneous microsized particles of superconductive ceramics. The particles are uniform in size, shape, and composition. After firing, more minute crystals are formed and superconductors can be made without problems more easily than by previous methods. In addition, they are reportedly effective in increasing the current density. It appears that the particles will be useful for practical application research of high temperature superconductors.

The particle production method used by both groups was called "Spray Thermal Decomposition Method," which ultrasonically sprays a solution of each raw material component in a solvent. The sprayed solution, together with oxygen, is sent to the reactor furnace; where it is heated to make ceramic particles. The raw material is a mixture of nitrates of yttrium, barium, and copper in a ratio of 1:2:3. The resulting particles are spherical with an extremely small and uniform diameter of less than one micron (one micron is one thousandth of one mm).

The key to achieving such a uniform diameter for the particles is the heating temperature. The research group discovered that good quality crystalline particles are produced at approximately 1,000° C. If heated at under 700° C particles are contaminated with impurities.

Currently, the main stream method is to heat and harden a mixture of powder oxides of yttrium, barium, and copper and then to pulverize it to produce the powder. The powder, however, is non-uniform in size and has not been suitable for making a superconductive material of a dense

texture. The spray thermal decomposition method will not only solve this problem but make the operation process shorter.

The superconductive made by the OPU and OPRCRI group achieved zero electric resistivity at 84° K (-189° C), while that made by the group of TIT achieved it at 90° K (-183° C). In these instances both groups experimented with a Y-base superconductor, but the method is said to be applicable to bismuth-based materials.

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Crystalline Anisotropy Examined

43067105d Tokyo NIKKEI SANGYO SHIMBUN in Japanese 7 Jun 88 p 3--FOR OFFICIAL USE ONLY

[Text] Toshiba General Research Institute confirmed for the first time that a new bismuth-base superconductor was anisotropic with remarkable directional variations in the crystalline characteristics. Electric resistance in the crystal's vertical direction (c-axis) was 35 times that in the horizontal plane (a-b plane). Because anisotropy is a deterrent to the commercialization of superconductive crystals, the clarification of its actual condition has been a research target.

Toshiba General Research Institute confirmed the fact by experimenting with oxide superconductors of bismuth, strontium, calcium, and copper. For the synthesis, the self-flux method, which is suitable in handling many raw materials, was used to produce a large crystal 7 mm in length, 5 mm in width, and 1 mm in height in the c-axis direction.

It is particularly difficult to grow the crystal in the c-axis direction. Previously, the highest has been 0.3 mm, which was achieved by the U.S. Argonne National Research Laboratory.

This superconductor is a Bi-based low temperature phase compound, which achieves zero resistivity at its critical temperature of 81.5° K (-192° C). When electric resistance was measured at 84° K, as the material was just starting to become superconductive, it was confirmed that there was almost no electric current in the c-axis direction.

The most plausible theory is that the structure of the a-b plane, made up of copper and oxygen atoms, controls the characteristics of the superconductor. For Y-based oxides, anisotropy has already been confirmed.

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about 700 A/cm^2 was obtained at 77 K in zero magnetic field. Dependence of J_c on the applied magnetic field has also been described.

Superconducting Bi-Sr-Ca-Cu-O Thin Films Prepared by Controlling Sputtering Conditions and Annealing Atmosphere

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 184

[Abstract of paper by K. Ohbayashi, T. Ushida, T. Tsunooka, K. Ohya, and H. Banno, NGK Spark Plug Co., Ltd.]

[Text] Bi-Sr-Ca-Cu-O thin films were prepared by using a RF magnetron sputtering. The films were grown on MgO substrates at 300°C cyclically by sputtering through a off-centered shutter hole while rotating the substrate table. Then the thin film sputtered substrates were annealed in a flowing gas atmosphere of O_2/N_2 at 860°C for 10 hrs.

No segregations of the constituent elements were observed in the sputtered thin films and high Tc phase-rich superconducting thin films Tc on = 120K, Tc zero >80K) were obtained at the O_2/N_2 gas flow ratio of 1/2 $\sim$ 1/10. On the other hand, a high Tc phase was not observed, but a low Tc phase-rich film (Tc on <80K) was obtained in a conventional continuous sputtering without rotation of the substrate table or by annealing at the O_2/N_2 gas flow ratio of 1/1 $\sim$ 1/0.

This method shall provide us an important information to make high Tc superconducting thin films of the Bi-Sr-Ca-Cu-O system.

Superconductivity on Single Crystals of Tl-Ca-Ba-Cu-O System

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 185

[Abstract of paper by H. Takei, T. Kotani, T. Kaneko, and K. Tada, Basic High-Technology Laboratories, Sumitomo Electric Industries, Ltd.]

[Text] The investigation for growth of single crystals of the Tl-Ca-Ba-Cu-O superconducting system is carried out using the flux growth method. The crystal structure and superconducting properties for mm-sized single crystals are measured by X-ray diffraction and SQUID magnetometer. The typical configuration of the crystals is that of a thin platelet form 1 to 2 mm wide and 0.2 mm thick. The surface of the crystals as observed by a scanning electron microscope and optical microscope, is very smooth like a mirror, with uniform distribution of composition. The superconducting onset transition temperature of 118K, the highest among previously reported data, is determined by the temperature dependence of DC magnetic susceptibility obtained for as-grown single crystals. From these results, the relationship between the crystal structure and superconducting transition temperature will be discussed.

Electron Tunneling Into Superconducting Bismuth-Copper Oxide Systems

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 186

[Abstract of paper by Toshikazu Ekino and Jun Akimitsu, Department of Physics, Aoyama-Gakuin University]

[Text] The energy gaps of the poly-crystalline Bi-Sr-Ca-Cu-O and Bi-Sr-Cu-O superconductors have been measured by means of the point-contact tunneling technique. We find that the energy gaps in Bi2Sr2CaCu2O(Tc=76K) are 2Δ=76$\sim$81meV, 91$\sim$100meV in Bi2Sr2Ca2Cu3Oy(Tc=105K) and 3.0$\sim$3.5meV in Bi2Sr2CuOy(Tc=6.5K). Temperature variations of these energy gaps are also extracted. The ratio 2Δ/kTc are 11.6$\sim$12.4 for Bi2Sr2CaCu2Oy, 10.0$\sim$11.0 for Bi2Sr2Ca2Cu3Oy, extremely larger than BCS value. On the contrary, 2Δ/KTc of Bi2Sr2CuOy is 5.4$\sim$6.2, somewhat larger than usual strong coupling superconductors. These results give the information about the difference of the pairing nature on the superconducting state between these materials which have multiple CuO layers and single CuO layer between the SrO layers.

Structural Investigation of High-Tc Bi-Sr-Ca-Cu-O

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 187

[Abstract of paper by J. Liu, H. Itoh, T. Shimizu, K. Ohmori, H. Matsuoka, M. Matsui, and M. Doyama, Department of Iron and Steel Engineering, Faculty of Engineering, Nagoya University]

[Text] A series of ceramic samples of nominal compositions, $BiSrCaCu_2O_x$, $Bi_2Sr_2CaCu_2O_x$ and $Bi_2Sr_2Ca_2Cu_3O_x$, were prepared by use of various heat treatments. Resistivity and magnetic measurements were performed and showed that major phases of these samples underwent superconducting transitions at 85K. X-ray diffraction studies were also conducted on these samples and they indicated that the major phases possessed an orthorhombic but nearly tetragonal structure with a = 3.824 A, b = 3.821 A and c = 30.69 A at room temperature. Temperature dependence of these lattice parameters were investigated over a wide range of temperature up to the melting points of these samples. It was then found that the lattice constants increased gradually as the temperature was raised and also that, in the two-phase sample of $BiSrCaCu_2O_x$, there appeared an extra phase at temperatures between 920 and 1030K, while the major phase at lower temperatures was greatly reduced in volume in this temperature range. This extra phase was found also in the sample of $Bi_2Sr_2CaCu_2O_x$ at room temperature. Therefore, in order to obtain a single-phase sample of $Bi_2Sr_2CaCu_2O_x$, it is rather crucial to understand the thermal behavior of this extra phase. We have thus attempted an extensive study to locate this phase in the Bi-Sr-Ca-Cu-O phase diagram.

An Observation of Quasi-Particle Tunneling Characteristics in All Y-Ba-Cu-O Thin Film Tunnel Junction

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 188

[Abstract of paper by Tetsushi Shiota, Kazushige Takechi, Yoshiaki Takai, and Hisao Hayakawa, Department of Electronics Engineering, Nagoya University]

[Text] This News reports the first trial to fabricate a tunneling junction using high Tc superconducting oxide (Y-Ba-Cu-O) thin films for both base and counter electrodes.

The tunnel junction with electrodes made of two crossing stripes of Y-Ba-Cu-O thin films was fabricated by an RF magnetron sputtering on an MgO substrate. A highly resistive thin barrier layer was prepared by plasma-fluorination of the surface of the Y-Ba-Cu-O base electrode prior to the deposition of the counter electrode.

A clear tunnel characteristic in a V-I curve with a well defined gap voltage and a small sub-gap leakage current was observed in the temperature range below 50K, although Josephson currents were not observed. The gap voltage was about 18 mV at 4.2K, decreasing as the temperature was increased. The gap structure was observed up to 77K which was about the superconducting on-set temperature of the electrode films.

This preliminary result strongly indicates a possibility to realize all high temperature oxide superconductor (Josephson) tunnel junctions which are quite useful for electronics applications.

Closing Address

43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 189

[Abstract of paper by S. Nakajima, Department of Physics, Tokai University]

[Text] The discovery of high-Tc oxides has raised two challenging problems: one is to make newly discovered materials available for superconductivity technology at liquid nitrogen or even higher temperatures and the other is to know the novel, most probably non-BCS mechanism of high-Tc superconductivity. These two problems, at least at the present stage of development, are so closely interrelated with each other that we need to invent some new scheme of effective cooperation among researchers of diverse disciplines. I would like to take this good occasion of ISS '88 provided by ISTEC to look, from that point of view, over the progress we have made in the past two years.

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43070701 Tokyo INTERNATIONAL SUPERCONDUCTIVITY TECHNOLOGY CENTER in English 28-31 Aug 88 p 197

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Linear-Motorcar Technology, Corporations Involved Discussed

43066104 Tokyo KABUSHIKI NIPPON in Japanese 5 Aug 88 pp 34-37

[Text] Linear Motorcar: Successor to Bullet Train

The meeting of the Special Committee of the ruling Liberal Democratic Party for Promoting the Consolidation and Construction of New Bullet Trains has entered into its final phase. The Committee is expected to reach a final decision by the end of August regarding the construction schedule for three long-awaited bullet train [Shinkansen] routes: the Tohoku route (Morioka to Hachinohe), the Hokuriku route (Takasaki to Toyama), and the Kyushu route (Hakata to Nishi-Kagoshima). Once completed, the new service routes will become a much needed treasure trove for the three railway companies: JR Higashi-Nippon, JR Tokai, and JR Kyushu.

Viewed from a larger perspective, the new Shinkansen construction represents a step forward in the direction of completing the fast mass transportation network, the central system of the National Resources Exchange Network. The concept of building this idealized National Resources Exchange Network was laid out in the Fourth Comprehensive National Development Plan by the Nakasone Government last June. Also, the problem of securing sufficient funds for the construction, which had been the biggest obstacle in resolving the specifics of the contruction in the past, is expected to finally be put to rest. The Committee is confident that the funding problem will be resolved soon when its so-called three-tier proposal is presented. Under this proposal, the national government will take care of 60 percent of the cost, while JR and the other private concerns will put in 30 percent, and the concerned prefectural governments the remaining 10 percent.

Altogether, the construction of the three Shinkansen routes is said to cost Y2.9 trillion. How are the construction-related businesses reacting to the long-waited, final draft of the construction schedule, expected to be announced shortly? The view expressed by Densetsu-Ko, a construction company of the JR family of companies, summarizes well the attitude, "We do want the construction of non-rail facilities like station buildings. But, to tell the truth, we have higher expectations for the construction of the more profitable Shinkansen tracks." (For the names of the major players in the new Shinkansen project, please refer to the table of companies involved in the JR linear motorcar development. Most of the companies listed play a role in both

projects.) It is certain that the sharing of the Y2.9-trillion pie will be a critical factor for the upward appraisal of the performance of the companies in the years to come. In addition to bringing a boost to company performance, the resolution of the new Shinkansen construction will mean bringing the long talked-about linear motorcar development to the center stage of national attention. Already, Miyazaki Prefecture has nominated itself as the host for construction of the linear motorcar test track facilities. The spokesman for Miyazaki's Department of Transportation which is responsible for activities designed to lure construction there said, "We have informed the Ministry of Transportation as to where our prefectural government stands and what it wants. All we can do now is to wait for the Ministry's selection of the site for the linear motorcar test track which is scheduled to be built within a year or two."

The next stage of the game concerns the "maglev", a linear motorcar based on superconductor-driven magnetic levitation. This is the new, fast mass transportation system of the future, which is under continuing development by the Railway Technical Research Institute (the JR Research Institute of Railways). The now privatized Japan National Railways began maglev R&D in 1962, two years before the inauguration of the Tokaido Shinkansen service, with the objective of developing a commercial train that cruises at 500 kilometers per hour. Since then, the JR Research Institute has conducted test runs using the 7-kilometer long straight track built in Hyuga City, Miyazaki Prefecture. In a recent test, the experimental model achieved a record speed of 400 kilometers per hour. The next step is to conduct the final phase of the test; to run a passenger-carrying model over an extended track. This requires building a test track over 50 kilometers or so, which may be converted into a commercial track once the test is completed. The government is expected to finish the site selection survey by the end of 1989, which is after it makes a decision on the new Shinkansen construction. In other words, the construction of the first linear motorcar line is just around the corner.

Projects for new lines by JR companies

Line	Route	Local govt.	Track length (km)	Cost (billion yen)	Scheduled date of completion	Railway company
Keiyo Line	Tokyo - Soga	Tokyo, Chiba	46.1	30.9	FY89	JR Higashi-Nihon
Seto Line	Katsugawa -Biwajima	Aichi	11.7	6	FY91	JR Tokai
Tsugaru-Kaikyo Line	Chushokoku - Kikonai	Aomori, Hokkaido	87.8	10	3-13-88 (inagurated)	JR Hokkaido
New Bullet Train Lines		Total cost: Y2.04 billion				
Study for Chuyo	Route:			Total cost: Y0.1 billion		

Bullet Train Line	Kofu - Nagoya	
Study for Shikoku Bullet Train Line	Route: Honshu - Awajishima	Total cost: Y0.1 billion

Companies That Benefit from Joint R&D of Maglev

Needless to say, the most remarkable feature of JR's new linear motor train regards its use of magnetic levitation. Because of the friction that appears between the wheels and the rails, conventional trains cannot go faster than 300 kilometers per hour. In order to break this speed barrier, the maglev is suspended in the air by the repulsive force of the electromagnets, and propelled by the alternating attractive and repulsive forces generated by the magnets of the linear motor. Because of this unique propulsion method, the operation of the train (i.e., acceleration, deceleration and breaking) is radically different from that of a conventional train, as one chief engineer at the JR Research Center expressed succinctly, "In short, the train is controlled not from the motorman's cab but from the power substation."

The motion of the train is controlled by supplying the coils, which lie on the ground alongside the track, with the right power frequency--for the train's speed--and the right voltage--for the necessary acceleration and deceleration from the cycloconverter (power converter) installed in the dedicated power substation. The company responsible for the development of this substation facility and the computer that controls it is none other than Hitachi Ltd.

As the reader may have noticed, the list of companies involved in the JR linear motorcar development is quite extensive. But, it is Hitachi, a leader in the high tech industry, that plays the central role in the R&D efforts. The experimental linear motorcar model MLU-002 now being tested in Miyazaki costs about Y1.5 billion per unit, while the future commercial version is said to cost Y0.6 billion to Y0.8 billion. The infrastructural installation, including the civil construction and the coil installation, is estimated to run about Y4 billion per kilometer of track. Although the construction of the 50-kilometer test track will not create much of an opportunity for Hitachi to cash in on, the company's firm grip on the roots of the new technology will definitely help in the future when the full scale construction of a linear motorcar network will take place nationwide.

While the construction of the "brain" and "artery" of the new transportation system goes to Hitachi, the development of the system's "heart", the motors, and the "legs", the coils and superconductor magnets, will go to Toshiba and Mitsubishi Electric, the other major league players that deserve special mention. Interestingly, the design of the "nervous system", the railway signal system, goes to the Nihon Signal Company.

Nihon Signal will be responsible for the development of the speed detection system that keeps track of the linear motorcar's speed at all points of its journey, and relays the monitored speed to the substation so that the substation can maintain the correct supply of power to the surface coils. The

high level of technology that Nihon Signal--a small company with a capital of only Y2.5 billion--possesses and which allows it to compete with the major league players in the fundamental system design of the maglev deserves full credit. (Of course, it is not always true that the more capital a company has the better its technology is.) In addition, the same company produces magnetic-strip card readers as well as failsafe devices for prevention of FA-related worker accidents, thus positioning itself as a representative, small-scale high-tech company associated with the JR project.

In the area of railway materials, Daido Steel deserves to be mentioned. Construction materials made of iron cannot be used near the surface coils. For example, the bolts that fasten the aluminum coils have to be made of a non-ferrous metal that does not become magnetized by the strong magnetic field generated by the superconductor magnets. And this is why Daido Steel's world class technology in specialized steel production was called for. The company will supply parts made of high-manganese non-magnetic steel that can be used in an environment consisting of an intense magnetic field. It is estimated that the volume of special steel that Daido Steel uses in the maglev project will reach Y340 million per kilometer of track, and that the volume required to complete the would-be 500-kilometer route between Tokyo and Osaka will exceed the Y150-billion mark.

Another valued company is Nippon Sharyo Company. This company has seen an increase of 33 percent in receipts, as compared to last term, and its EPS is forecast to go up to Y15, since the demand for trains by the seven JR companies increased to 9,500 cars just last term (calculated in an equivalent number of freighter cars), up by 105 percent over the previous term. The sharp upturn in demand indicates a rapid recovery of the JR family of companies to a level of performance comparable to that before the JNR privatization. Once the linear motorcar program goes into a mass production phase, Nippon Sharyo's performance should look even brighter.

Companies in the JR linear motorcar development

Developer	Railway Technical Research Institute (JR Research Institute of Railways)
Co-developers	Hitachi, Toshiba, Mitsubishi Electric, the Nihon Signal, Nippon Sharyo
Linear motor & superconductor coils	Mitsubishi Electric, Toshiba, Sumitomo Electric Industries, the Furukawa Electric, Showa Electric Wire & Cable, Hitachi Cable, Sumitomo Heavy Industries, Aishin Seiki, Kobe Steel
Body & chassis	Nippon Sharyo, Kawasaki Heavy Industries, Hitachi, Tokyu Car Corp., the Kinki Sharyo, BS
Computer control & signal processing	Hitachi, Hitachi Plant Engineering & Construction, the Nihon Signal
Materials	Nippon Light Metal, Sumitomo Light Metal Industries, Showa Aluminum, Daido Steel, Kobe Steel, Nippon Steel, Sumitomo Metal Industries, Fujikura, Mitsubishi Cable Industries, Nippon Sanso, Daido Sanso
Installation of tracks	Electric Facilities Industry Co, Chitose Electrical Construction, Tekken Construction
Construction related work	Totetsu Kogyo, Hoan Kogyo, Morio Denki, Kyosan Electric Manufacturing, Daido Signal, Miyaji Iron Works, Kajima Corp., Taisei Corp., Ohbayashi Corp., Kumagai Gumi, Hazama-Gumi, Sato Kogyo, Meiko Construction, etc.

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